DIVISION 800 MATERIAL DETAILS

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SECTION 800 MATERIAL DETAILS

Where any Specification or test has an AASHTO or ASTM number followed by the word "Modified", it shall mean as modified by the Delaware Division of Highways Materials Manual in effect on the date of advertisement for bids.

Whenever any material is required for the work, the Contractor warrants and agrees that such material has been tested and shall be suitable, compatible, and useable in the work and for the Project.

QUALITY CONTROL

The Contractor shall perform all tests required by the Contract and such other tests that the Contractor shall determine are necessary to verify the quality and suitability of all materials used in the Project. For all required tests, the Contractor shall submit test results or samples as requested by the Department, and shall obtain necessary approvals prior to use on the Project. The approval of any material or source of supply of such material shall not relieve the Contractor of the responsibility to supply a material which is compatible with all other materials to be used on the Project, as such materials are normally used, without defect and for the anticipated life of the Project. The Contractor warrants that all materials used in the work or Project shall be made, manufactured, processed, or produced by suitable means, that all materials have been tested with satisfactory results, and that all materials may be compatibly incorporated into the work or Project without defect. The Contractor further warrants with respect to all materials used on the Project that:

a. The ownership and title to such materials shall be clear when incorporated and used in the work or Project and the Contractor shall have the right to lawfully transfer ownership or title of all materials used in the work to the Department. All materials used in the work shall be free from any security interest, lien, or other incumbrance. It shall be the sole responsibility of the Contractor to resolve any security interest, lien, or other incumbrance placed on materials used in the work or Project.

b. All materials used in the work shall be merchantable, shall be fit for the ordinary purpose for which such material is used, and shall be fit and useable for the particular purpose for which such material is intended to be used in the work or Project, as such terms are used in the Delaware Uniform Commercial Code.

   Any material which is not merchantable, not fit for the ordinary purpose for which such material is used, or which is not satisfactory for use for the particular purpose required in the work or Project shall be considered as defective. It shall be the Contractor's responsibility to determine that the material meets these criteria, and the Contractor warrants that any and all necessary tests or evaluations of such material have been made to determine material compatibility and suitability for use in the work or Project.

SECTION 801 PORTLAND CEMENT AND BLENDED HYDRAULIC CEMENTS

This material consists of Portland cement and blended hydraulic cements conforming to the following requirements:

a. *Portland Cement.* Portland cement shall conform to the requirements of AASHTO M 85, except "Fineness" shall be measured by the air permeability test, and a maximum specific surface of 420 m^2/kg will be permitted. Unless otherwise specified, cement shall be either Type I or Type II.

b. *Blended Hydraulic Cements.* Type IP or Type I(PM) or Type IS or Type I(SM) cement, conforming to the requirements of AASHTO M 240, will be permitted as an alternate to Type I or Type II cement in all classes of concrete, subject to the following conditions:

Type IP or I(PM): (fly ash)

Type IS or I(SM): (ground granulated blast furnace slag)

Reserved bins shall be sampled by the Department or its authorized representative, and all tests shall be completed before the cement is accepted. Only pretested and accepted cement shall be used.

Orders for cement shall be placed with the manufacturer at least ten days before the first shipment is made.

Railroad cars and truck transports used to transport bulk cement shall be of a design that can be properly and completely unloaded. They shall be loaded and sealed by authorized representatives of the Department, and the seals will be removed by authorized representatives of the Department.

All cement used in any one Contract item shall be of a single brand, from a single mill, unless otherwise authorized in writing by the Engineer.

Upon approval from the Engineer, the preceding requirements for reserved bins and sealed shipments may be waived if the cement manufacturer qualifies for inclusion in the program of certification.

A manufacturer may become qualified by establishing a history of satisfactory quality control of cement produced as evidenced by results of tests performed by the Department and the manufacturer's testing laboratory, and upon approval of production and storage facilities by the Engineer. The manufacturer shall conduct sufficient tests to ensure that adequate quality control is maintained and that cement furnished conforms to the specification requirements. The manufacturer shall maintain a record of all tests for review by the Engineer. Samples for tests of any cement may be taken at any time necessary as determined by the Engineer.

Cement manufacturers will be furnished specific details on requirements; however, the Engineer reserves the right to modify the program for all participants, as required, or to impose additional or special requirements on manufacturers as considered necessary to maintain control.

Any manufacturer who fails to cooperate in a satisfactory manner or cannot furnish cement within the established limits of acceptance will be required to cease participation in the certification program. In such cases, pretesting, reserved bins, and sealed shipments will be required.

The temperature of the portland cement at the time of delivery to the paver or mixer shall not exceed 150 ºF (66 ºC).

SECTION 802 NORMAL FINISHING HYDRATED LIME

Finishing hydrated lime shall conform to the requirements of ASTM C 206, Type N.

SECTION 803 WATER FOR MIXING PORTLAND CEMENT CONCRETE

Water used in mixing, curing, or other designated applications shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water will be tested in accordance with AASHTO T 26. Water known to be of potable quality may be used without testing. Where the source of water is relatively shallow, the intake shall be enclosed to exclude silt, mud, grass, or other foreign materials.

The water shall conform to the following requirements:

Hydrogen ion concentrations	4.5 to 8.5 pH
Total solids	5000 ppm
Total chlorides	300 ppm
Soluble SO_4	500 ppm
Total alkalis as Na_2 plus $0.658K_2O$	500 ppm
Organic content	2000 ppm
Compressive strength, minimum	90% of control
Time of setting, Vicat	60 minutes from control and within the specifications of AASHTO M 85

SECTION 804 FINE AGGREGATE

Fine aggregate for use in Portland cement concrete shall conform to the requirements of AASHTO M 6, except the grading shall:

Sieve Size	***Percent Passing***
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	95 - 100
No. 50 (300 Fm)	5 - 30
No. 100 (150 Fm)	*Fineness Modulus:*2.3 to 3.1

The organic impurities requirement will be waived for fine aggregate specified for uses other than in portland cement concrete.

SECTION 805 COARSE AGGREGATE

Coarse aggregate shall conform to the requirements of AASHTO M 80 except no gravel, crushed gravel, or crushed concrete shall be used. Also, the requirements of Section 2.1, percentage of wear, Los Angeles Test, shall not be more than 45%. If air-cooled, blast-furnace slag is used, it shall weigh not less than 70 pounds per cubic foot (1.12 metric tons per cubic meter) when tested according to AASHTO T 19/T 19M.

SECTION 806 CALCIUM CHLORIDE

Calcium chloride shall be Type S, Grade 1, Class A conforming to AASHTO M 144.

SECTION 807 MATERIAL FOR RESEALING JOINTS AND CRACKS

This material shall consist of a blend of asphalt cement and 18 " 2% by weight of a mixture of recycled, reclaimed crumb rubber.

MATERIALS

a. *Asphalt.* The asphalt used shall have a maximum penetration of 150 as determined by AASHTO T 49.

b. *Crumb Rubber.* The recycled, reclaimed crumb rubber used in the mixture:

1. shall be produced from a process that crushes, tears, grinds, or abrades the used rubber at or above ordinary room temperature, and produces rubber particles with a very ragged, sponge-like surface. Grinding rubber at cryogenic temperatures is prohibited.
2. shall contain recycled, vulcanized crumb rubber or reclaimed, devulcanized rubber, or both.
3. shall contain a minimum of 25% natural rubber by weight of the total rubber portion of the mixture.
4. shall contain no more than a trace of fabric.
5. shall be free of wire and other contaminating materials, except that up to 4% calcium carbonate or talc may be included to prevent the rubber particles from sticking together.
6. shall have no rubber particles greater than 3" (6 mm) in length.
7. shall conform to the following gradation requirements:

Sieve Size	***Percent Passing***
No. 10 (2.00 mm)	100
No. 16 (1.18 mm)	90 - 100
No. 30 (600 Fm)	40 - 80
No. 80 (180 Fm)	0 - 10

MIXTURE REQUIREMENTS

a. *Pour Point.* The pour point shall be at least 20 EF (11 EC) lower than the safe heating temperature, which is the maximum temperature to which the material may be heated without exceeding the permitted flow.

b. *Cone Penetration.* Penetration shall not exceed 90 at 77 EF (25 EC), 150 g, five seconds.

c. *Flow.* The flow shall not exceed 5 mm at 140 EF (60 EC).

d. *Bond.* The sealant shall be tested at 0 EF (-18 EC) for five complete cycles. The development at any time during the test procedure of a crack, separation, or other opening that at any point is over 3" (6 mm) deep in the sealant or between the sealant and mortar block, shall constitute failure of the test specimen. The depth of the crack, separation, or opening shall be measured perpendicular to the side of the sealant showing the defect. At least two test specimens in a group of three representing a given sample of sealant shall meet this requirement for bond.

e. *Packaging.* The pre-mixed sealant shall be packaged in units weighing no more than 30 lb (13.6 kg) with a maximum of two 30 lb (13.6 kg) units per shipping container. The plastic film used in packaging the units shall readily melt at normal application temperatures when placed in the installation equipment. Bonding or sticking of the packaged units to each other or to the shipping container or packaging causing unnecessary contamination of the sealant with staples and fasteners, as determined by the Engineer, shall be sufficient cause for rejection of the material.

SECTION 808 JOINT SEALS AND SEALANTS

808.01 Description. This material shall consist of seals and sealants for Portland cement concrete joints.

808.02 Portland Cement Concrete Pavement. Materials for sealing joints in Portland cement concrete pavement shall be as follows:

a. *Hot-Poured Joint Sealant.* Hot-poured joint sealant shall conform to AASHTO M 301 or AASHTO M 282.

b. *Preformed Elastomeric Compression Joint Seals.* Preformed elastomeric compression joint seals shall conform to the requirements of AASHTO M 220. The lubricant used to install the preformed elastic joint sealant shall be a one-component, polychloroprene compound containing only soluble phenolic resins blended together with anti-oxidants and acid acceptors in an aromatic hydrocarbon solvent mixture and shall have the following physical properties:

   1. Average net weight per gallon: 7.84 lb (liter:0.94 kg) +5%.
   2. Solids content by weight: 22 to 28%.
   3. Viscosity shall be such that the lubricant performs suitably with the installation equipment.
   4. The lubricant shall remain fluid from 5 to 120 EF (-15 to 49 EC).
   5. Film strength (ASTM D 412): 2300 psi (16 MPa) minimum tensile strength, 750% minimum elongation before breaking.
   6. The lubricant shall be stored at a temperature between 50 and 80 EF (10 and 27 EC). Any lubricant not used within 270 days of its manufacture shall be unacceptable.

c. *Low-Modulus Silicone Rubber Joint Sealant.* Low-modulus silicone rubber joint sealant to be used on the Project shall be submitted for approval by the Engineer.

808.03 Continuously Reinforced Portland Cement Concrete Pavement. Materials for sealing joints in continuously reinforced Portland cement concrete pavement shall conform to AASHTO M 282.

808.04 Portland Cement Concrete Structures. Materials for sealing joints in Portland cement concrete structures shall be as follows:

a. *Preformed Elastomeric Compression Joint Seals.* Preformed elastomeric compression joint seals shall be composed of open cell polychloroprene and conform to AASHTO M 220.
b. *Rubber Joint Sealant.* Rubber joint sealant shall be a multipart chemically curing polyurethane or polysulfide sealant which meets or exceeds the curing requirements of Federal Specification TT-S-00227E(3), Type I (Flow Type) and Type II (Nonsag Type), Class A, (Compounds resistant to 50% total joint movement). The color shall be grey to match the concrete.
c. *Bituminous Joint Sealant.* Bituminous joint sealants may be hot applied conforming to AASHTO M 173 or equivalent, or cold applied elastomeric sealant conforming to Federal Specification SS-S-200E(2), Type H.
d. *Preformed Expansion Joint Material.* Unless otherwise specified on the Plans or in the Special Provisions, preformed expansion joint material for Portland cement concrete structures shall conform to the requirements of AASHTO M 153, Type III, self-expanding cork.

808.05 Concrete Slope Paving. Materials for sealing joints in concrete slope paving shall be as follows:

a. *Hot-Poured Joint Sealant.* Hot-poured joint sealant shall conform to the requirements of Subsection 808.02 (a).

b. *Preformed Expansion Joint Material.* Preformed expansion joint material shall conform to the requirements of AASHTO M 153, Type I.

808.06 Portland Cement Concrete Curb and Integral Curb and Gutter. Materials for Portland cement concrete curb and integral curb and gutter shall be preformed expansion joint material of 2" (13 mm) nominal thickness and shall conform to the requirements of AASHTO M 153, Type II or Type III. Preformed expansion joint material of other types may be used for Portland cement concrete curb and integral curb and gutter provided they are approved by the Engineer.

SECTION 809 EMULSIFIED ASPHALT FOR STABILIZATION

Asphalt for soil stabilization shall be a high-float, medium setting emulsion conforming to the requirements of AASHTO M 140, Grade HFMS-2s.

SECTION 810 ASPHALT CEMENT

Asphalt cement shall be prepared by the refining of crude petroleum using methods conforming to industry standards. The asphalt cement shall conform to the requirements of AASHTO M 226, Table 2.

When tested by ignition, the inorganic insoluble residue content of the asphalt cement shall not exceed 0.25% by weight.

SECTION 811 EMULSIFIED ASPHALT

Emulsified asphalt shall conform to the requirements of AASHTO M 140 for anionic emulsions or AASHTO M 208 for cationic emulsions.

SECTION 812 PORTLAND CEMENT CONCRETE

812.01 Description. This material consists of portland cement, fine aggregate, coarse aggregate, water, and admixtures mixed in the specified proportions for the various classes of concrete.

812.02 Materials.

a. *Portland Cement.* Portland cement shall conform to the requirements of Section 801.

b. *Water.* Water shall conform to the requirements of Section 803.

c. *Fine Aggregate.* Fine aggregate shall conform to the requirements of Section 804.

d. *Coarse Aggregate.* Coarse aggregate shall conform to the requirements of Section 805.

e. *Gradation.* Coarse aggregate shall conform to the requirements of Section 813, No. 57.

f. *Air Entrainment Agent.* An air-entrainment agent conforming to the requirements of AASHTO M 154 shall be introduced into the mixer by an approved automatic dispenser.

g. *Chemical Admixtures.* Chemical admixtures shall conform to the requirements of AASHTO M 194 for the seven types as follows:

Type A - Water Reducing
Type B - Retarding
Type C - Accelerating
Type D - Water Reducing and Retarding
Type E - Water Reducing and Accelerating
Type F - Water Reducing, High Range
Type G - Water Reducing, High Range and Retarding

For concrete Classes A and D, calcium chloride or other admixtures containing detrimental amounts of chloride salts shall not be used in the concrete. The chloride content of bridge deck concrete shall not exceed 0.10% by weight of cement.

h. *Fly Ash.* Fly ash may be used as an additive in concrete in order to promote workability and plasticity. Fly ash shall conform to the requirements of Section 822.

i. *Curing Materials.* Curing materials shall be as follows:

1. *Liquid Membrane Compounds.* The material shall conform to the requirements of AASHTO M 148, for Type 2, Class A or B white-pigmented liquid curing compound. Acceptance for continued use will be based upon satisfactory field performance.
2. *Polyethylene Sheeting.* Polyethylene sheeting shall conform to the requirements of AASHTO M 171.
3. *Waterproof Paper.* Waterproof paper shall conform to the requirements of AASHTO M 171. The name of the manufacturer shall be marked or imprinted clearly on the paper for proper identification.
4. *Water Cure.* The water shall conform to Section 803.

j. *Samples.* The source of fine aggregate, coarse aggregate, cement, additives, and admixtures shall be submitted to the Department's Materials and Research Section prior to any concreting operations in sufficient time so mix design verification may be performed.

Coarse and fine aggregates for use in Portland cement concrete mixtures will also be evaluated for potential alkali-silica reactivity using ASTM C 1260 Mortar Bar Method and may be evaluated by ASTM C 295 Petrographic Examination. Furthermore, if available, field service records of the aggregate in concrete will be evaluated. Aggregate sources determined to be reactive with cement alkali will be permitted in concrete mixtures using either low alkali (0.6% or less) cement or Type IP cement. Use of high alkali cement will be permitted with these aggregates provided one of the following options is used to modify the cement matrix:

1. Substitution of 35 to 50% of the Portland cement with ground granulated blast furnace slag conforming to AASHTO M 302, Grade 100 or Grade 120;
2. Substitution of 7 to 10% of Portland cement with silica fume conforming to the requirements of AASHTO M 307; or
3. A minimum 20% substitution of Portland cement with fly ash conforming to Section 822; or
4. Use of a lithium-based admixture at a dosage rate based upon the sodium oxide equivalent (AASHTO M 85) of the Portland cement component of the concrete. The lithium dosage shall be 1 lb (1 kg) of lithium hydroxide monohydrate per 1 lb (1 kg) of sodium oxide equivalent of the Portland cement, with a minimum dosage of 0.60% by weight of the Portland cement. Other approved lithium compound may be used but shall be dosed in equivalents of lithium hydroxide monohydrate. All lithium salts shall be certified as non-hazardous based on the heavy metal content. Mixing shall be as per manufacturers recommendation.

k. *Fiber Reinforcement*. Fiber reinforcement shall conform to the requirements of Subsection 824.02(j).

812.03 Handling and Storing Materials.

a. *Aggregate.* Aggregate stockpiles shall be placed on hard, clean, and well drained surfaces of acceptable materials such as Portland cement concrete, or hot-mix bituminous concrete and be of sufficient thickness to withstand the loadings of construction equipment. If, at any time, the surfaces break up so as to possibly contaminate the aggregate stockpiles, the concrete operation shall be immediately stopped until such time that the surfaces may be repaired. Prior to stockpiling aggregates, the Department's Materials and Research Section shall be contacted for approval of the base surface material. Coarse and fine aggregate shall be kept separate during transportation, handling, and storage until batched. If necessary, suitable partitions shall be constructed to prevent mixing of the fine and coarse aggregates.

Aggregate stockpiles shall be constructed in horizontal layers not exceeding 5' (1.5 m) in depth in order to avoid segregation. Segregated material shall be removed from stockpiles and disposed of or remixed to the satisfaction of the Engineer.

Fine aggregate shall be stockpiled at the batch plant a minimum of 24 hours prior to batching or longer if required until surplus water has disappeared and the material has a uniform free moisture content. Wet fine aggregate shall not be placed where it becomes mixed with material being used for batching. Suitable partitions shall be constructed to prevent mixing of the wet fine aggregate and the fine aggregate being used for batching. Batching direct from the washing plant will not be permitted.

Haul roads to the concrete plants shall be of such base as to prevent any deleterious materials from being incorporated into the stockpiles and into the concrete itself. If at any time, deleterious materials are found in the stockpiles, the concrete operation shall be immediately stopped.

b. *Cement.* Reclaimed cement or cement that shows evidence of hydration, such as lumps or cakes, shall not be used. All cement shall be stored in suitable weatherproof structures that protect the cement from dampness.
c. *Fly Ash.* Fly ash which shows evidence of hydration, such as lumps or cakes, shall not be used. All fly ash shall be stored in suitable weatherproof structures that protect the fly ash from dampness and other contamination.
d. *Admixtures.* Admixtures shall be stored and handled in such a manner that contamination or deterioration is prevented. Admixtures shall not be used unless thoroughly agitated to the satisfaction of the Engineer or the Engineer's agent. Partially frozen admixtures shall not be used. When the amount of admixture required to give the specified results deviates appreciably from the manufacturer's recommended dosage, the use of this material shall be discontinued unless conditions justify a change in the dosage.

812.04 Composition of Mix. The Engineer will determine the proportions of materials to be used that will produce a workable, dense, concrete conforming to the requirements of Table 812-A for the class of concrete specified. ACI design methods will be used as a guide in determining aggregate proportion.

Exceptions to these requirements are as follows:

a. The producers of prestressed, precast reinforced concrete items complying with these specifications shall determine mix design proportions for concrete proposed for use. The mix design proportions shall be submitted to the Department's Materials and Research Section for approval prior to use.

b. The Contractor shall submit to the Department's Materials and Research Section sources of all materials and mix design proposed for production of Class D concrete prior to any work. Such submission shall be made in sufficient time for preparation of laboratory or field trial mixes and 28-day strength determinations. Field trial mixes shall be made at the concrete supply location and shall consist of 3 yd; (2.3 m^3) (minimum) batches of concrete. All materials, equipment, and labor required to produce the field trial mixes shall be supplied by the Contractor.

c. For slip-form paving, concrete shall be Class B with the following restrictions:

    1. The composition of the mix shall be such to produce concrete with a slump of 1 to 22" (25 to 65 mm) when tested at the time of placement in accordance with AASHTO T 119.

    2. Concrete shall be "central mixed".
    3. Transportation of the concrete shall be only by approved trucks that demonstrate satisfactory loading at the central mix plant and unloading at the Project site.

    4. The design strength shall be 3500 psi (24 MPa) compressive strength at 28 days.

    The Engineer will determine the proportions of materials to be used that will produce a workable, dense concrete conforming to the requirements of this Section, Class B as modified above. Should proportions determined by the Engineer vary due to changes in the material originally submitted, no additional compensation will be made. To improve mix workability and consistency, the Contractor may substitute at its expense up to 50% of the Type I portland cement in the Class B mix with ground granulated blast-furnace slag meeting the requirements of AASHTO M 302, Grade 120. The ground slag-Portland cement blend will be approved by the Engineer prior to use and may be adjusted at the discretion of the Engineer as field conditions warrant. ACI design methods will be used as a guide in determining aggregate proportions that will produce a workable, plastic concrete having the specified design strength.

Should the proportions determined by the Engineer vary due to changes in the materials originally submitted by the Contractor, no additional compensation will be made.

d. Producers wishing to use fly ash as an additive or a partial replacement for Portland cement, shall determine the mix design proportions for the concrete proposed for use. Fly ash use as partial replacement for Portland cement in mixtures containing Type I (PM) or IP cement is prohibited.

For mixes containing fly ash, laboratory testing, which is the responsibility of the producer, shall be performed documenting the design's conformance to all requirements and noting that air entrainment is of special concern. Identification of the sources of materials, the mix design proportions, and the results of the laboratory testing of the proposed mix design shall be submitted to the Department's Materials and Research Section for approval prior to use of the design. The producer shall supply appropriate samples of the design materials. The Contractor shall allow for up to five weeks for evaluation by the Department's Materials and Research Section.

When a mix containing fly ash is used, the Contractor shall perform extra sampling and testing of the concrete mixture, as deemed necessary by the Engineer, in order to detect possible harmful variations in the quality of the mix before forms and supports are removed and loading applied. Samples shall be cured in the same ambient temperature as the placed material, in order to more accurately represent the strength of the placed material. Delays due to slow strength gain from a fly ash mix shall not be considered for an extension of time allowed for the completion of the Project.

The requirements of each class of concrete specified are included in the following table:

Table 812-A

Class of Concrete	*A*	*B*	*C*	*D*
Design Compressive Strength, fN_c at 28 days, psi (Note1) (MPa)	4500 (30)	3000 (20)	2000 (15)	4500 (30)
Design Cement Content, minimum, sacks/yd; (Note 2)(sacks/m5) lb/yd; (kg/m;)	7 1/2 (9.8) 705 (418)	6 (7.8) 564 (334)	4 1/2 (5.9) 423 (251)	7 1/2 (9.8) 705 (418)
Design Water to Cement Ratio, W/C = (Note 3)	0.40	0.45	0.60	0.40
Required Air Content, % (Note 4)	4-7	4-7	4-7	4-7
Required Slump,in (Note 5) (mm)	2-4 (50-100)	2-4 (50-100)	2-4 (50-100)	2-4 (50-100)
Required Admixtures (AASHTO M 194) (Notes 6 and 7)	A, D, F, G	A, D, E, F, G	A, D, E, F, G	A, D, F, G
Notes 8, 9, 10, and 11 refer to all classes of concrete.				

Note 1: In addition to meeting the specified $f\,N_c$ design compressive strength, Class D concrete shall achieve f_{cr}, which is the required average compressive strength for $f\,N_c$. The required average compressive strength, f_{cr}, shall be the minimum compressive strength required for mix approval and shall be in excess of the 4500 psi (30 MPa) design compressive strength, $f\,N_c$. The degree of excess compressive strength necessary shall depend on expected uniformity of concrete production as per criteria established in the ACI Standard 214. Upon establishment of standard deviation data, the following ACI 318M required average compressive strength values shall govern acceptance of the trial mix proportions:

f_{cr}= 4900 psi (33.8 MPa) if standard deviation is less than 300 psi (2.1 MPa)

= 5050 psi (34.8 MPa) if standard deviation is within 300 to 400 psi (2.1 to 2.8 MPa)

= 5200 psi (35.8 MPa) if standard deviation is within 400 to 500 psi (2.8 to 3.5 MPa)

= 5400 psi (37.2 MPa) if standard deviation is within 500 to 600 psi (3.5 to 4.1 MPa)

If the standard deviation exceeds 600 psi (4.1 MPa), the concrete production facility shall be unacceptable for Class D concrete production. A probability of not more than one in ten tests falling below the specified compressive strength will be used to compute the required compressive strength. The average 28-day compressive strength of two companion molded 6 by 12" (152 by 305 mm) or 4 by 8" (102 by 203 mm) cylinders prepared from the same batch of concrete shall be considered a "test".

Note 2: For Class D concrete, the average compressive strength and coefficient of variations shall be computed upon the availability of 28-day compressive strength data comprising a minimum of 15 tests from the concrete production plant. Should these determinations indicate an excessive margin of safety, the concrete mix may be modified to produce a lower average compressive strength as approved by the Department's Materials and Research Section, but in no case shall the cement content be reduced to less than 7 sacks/yd;(658 lb/yd;) [9.2 sacks/m^3 (390 kg/m^3)]. Should determination indicate a lower average compressive strength or a higher coefficient of variation than anticipated, the quality of the concrete will be evaluated, and mix proportions adjusted as required; however, cement content may not exceed 8 sacks/yd; (752 lb/yd;) [10.5 sacks/m^3 (446 kg/m^3)].

Note 3: Water to cement ratio may be expected to vary "5% depending on varying atmospheric and other related conditions.

Note 4: Water reducing admixtures shall be required in all concrete. The quantity and AASHTO type or combination of AASHTO types of admixtures shall be determined by the Contractor depending on the ambient temperature, concrete temperature, time of day, thickness of concrete, concrete mix proportions, etc. and the amount and proper type of superplasticizer and/or retarder necessary. The Contractor shall be responsible for the quality of the concrete placed in any weather or atmospheric condition. Failure to achieve a satisfactory product shall be corrected as directed by the Engineer at the Contractor's expense.

Note 5: If a Type F or G admixture is used, the maximum slump shall be 8" (200 mm).

Note 6: The total chloride content of concrete mixtures, when tested in accordance with the requirements of AASHTO T 260, shall not exceed the following:

a. Prestressed concrete:0.06%.

b. Conventionally reinforced concrete in a moist environment and exposed to chloride deicing salts or marine conditions:0.10%.

c. Conventionally reinforced concrete in a moist environment or areas with potential moisture condensation but not exposed to chloride:0.15%.

Limits are expressed as a percentage of the total weight of the Portland cement and fly ash in the concrete mix.

Note 7: In calculating the "Water to Cement Ratio" for mixes containing cementitious materials other than Portland cement, the weight of the Portland cement plus the weight of the cementitious material represents the weight of cement.

Note 8: Consistency of the mix shall be determined by AASHTO T 119. Air content shall be determined by AASHTO T 152, Modified, or AASHTO T 196. Making and curing concrete test specimens shall be in accordance with AASHTO T 23 and it shall be the responsibility of the Contractor to ensure that the seven- and 28-day cylinders are cured for the first 24 to 48 hours in an environment to provide satisfactory moisture and temperature control as per AASHTO T 23.

Note 9: Concrete shall be placed only if the surface evaporation rate, as affected by ambient air temperature, concrete temperature, relative humidity, and wind velocity is less than or equal to 0.15 lb/ft5 (0.73 kg/m^2) per hour. The Contractor shall determine and document the evaporation rate at the site of the concrete placement, subject to verification by the Engineer. The chart contained in "Plastic Cracking of Concrete" by Delmar Bloem for the National Ready Mixed Concrete Association and published in ACI 305R-89 shall be used to determine the loss of surface moisture for the concrete. The chart may be obtained from the Department's Materials and Research Section.

Note 10: Fixed-form concrete shall meet all requirements of Class B except the 28-day compressive strength shall be 3500 psi (24 MPa).

Note 11: The Contractor has the right to modify their mix design for any class of concrete. The modified mix design will be reviewed by the Engineer prior to approval. The approval will be based upon tests performed by the Contractor and approved by the Engineer.

Note 12: Class D concrete shall have fiber reinforcement added at the rate of 1.5 lb/yd; (0.90 kg/m;).

812.05 Mix Temperature Limitations. The Contractor shall be responsible for the quality of the concrete placed in any weather or atmospheric conditions.

The concrete shall have a temperature of 70 " 20 ºF (21 " 11 ºC) at the time of placement unless prior permission has been granted to exceed these tolerances; however, concrete for bridge decks shall not exceed 85 ºF (30 ºC).

In hot weather, the water or aggregate, or both shall be cooled as necessary to maintain the concrete temperature within the specified limits. When the temperature of the plastic concrete reaches 84 ºF (29 ºC) at the mixing plant, particular attention shall be given to the sprinkling and wetting of the foundation and forms, the maintenance of the coarse aggregate stockpile in a saturated surface-dry condition through use of stockpile sprinklers, the placing and finishing operations, and the prompt starting of the curing operation. When the temperature of the plastic concrete reaches 90 ºF (32 ºC) at the mixing plant, immediate steps shall be taken to cool the mixing water or aggregate, or both in order to maintain a plastic concrete temperature of 90 ºF (32 ºC) or less. If such actions are not successful in reducing the concrete temperature, mixing operations shall cease.

812.06 Delivery Restrictions. The time elapsing between the introduction of water to the mix and the placing of the concrete shall be 30 minutes maximum for non-agitating type haul equipment or 60 minutes maximum for agitating type haul equipment. For Class B slip-form concrete, the time elapsing between the introduction of water to the mix and the placing of the concrete shall be 45 minutes maximum for non-agitating type haul equipment of 60 minutes maximum for agitating type haul equipment. Any concrete which has not been placed within these time limits will be rejected for use in the work. These delivery time restrictions may be extended by the Department's Materials and Research Section when an approved water reducing and set retarding admixture is used provided the concrete remains workable for the use intended.

The interval between placing successive loads shall be as directed, however, in no case shall the interval exceed 20 minutes in order that concrete in place shall not have become partially hardened prior to placing successive batches, unless approved in writing by the Engineer.

The method and time of delivery shall be controlled by plant slips signed by the Engineer and issued to the truck driver. The slips shall indicate the name and location of the plant, the size and proportions of the batch, type of admixture used, and the time the mixer is charged. Upon arrival on the job, each slip shall be delivered to the Engineer and will be completed to show the time the concrete is discharged from the truck.

The Contractor shall notify the Department's Project and plant inspectors at least 24 hours prior to the placement of any concrete so that inspection services can be provided.

812.07 Plant and Equipment Requirements

a. *General Requirements.* All concrete batch plants offered for Department approval shall be equipped for automatic batching and proportioning of all cement, aggregates, and water and for visual observation of automatic insertion of admixtures.

   All currently approved concrete batch plants shall retain approved status, unless the approval is rescinded for failure to comply with the batch plant requirements specified herein and the requirements of the current version of

AASHTO M 157 for concrete batch plants. In the case where approval is rescinded, reinstatement shall be on the basis of the requirements for automation as specified for approval of plants in the previous paragraph.

The batch plant and all equipment and facilities necessary for performing the work will be inspected and approved by the Engineer as to design, capacity, and condition well in advance of the start of construction. The batch plant shall conform to the requirements of AASHTO M 157, except as modified herein.

A laboratory of 150 ft5 (14 m^2) minimum shall be provided for the exclusive use of the Engineer at all Portland cement concrete facilities. The producer shall furnish all heat, lights, air conditioning, telephone, electric, bottled drinking water, tables, desk, chairs, file cabinets, and all testing equipment or devices to control the production and quality of the concrete. Approved sanitary facilities shall be furnished and maintained.

Inspection of all equipment incidental to the production and transportation of concrete will be performed by the Engineer either on an annual basis or prior to commencement of work on the Contract. If at any time during construction, the equipment is not performing satisfactorily, it shall be repaired prior to re-use. If the concrete plant is to be used for night pours, ample lighting shall be provided to satisfactorily illuminate the aggregate stockpiles along with all areas where the Engineer or the Engineer's representative will be performing testing.

1. *Bins and Hopper.* The bins shall be in good condition and have adequate separate compartments for fine aggregates and for each required size of coarse aggregate. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision.

   The hopper and its appurtenances shall be constructed to eliminate the retention of varying tare materials on any of its parts and operated to ensure a rapid and complete discharge without shaking and jarring the scales.

2. *Weighing Equipment.* The scales for weighing material shall be either of the horizontal beam or the springless dial type and shall be the product of an established manufacturer. They shall be of rugged design, constructed to support the hopper or hoppers and with minimum adjustments consistent with the accuracy required. Scale levers shall be of such design, construction, and material to permit frequent handling without damage.

   Pivots shall be of steel, sufficiently hardened and tempered to ensure minimum wear under a heavy volume of weighing. They shall be accurately set in substantial mountings to ensure a permanent spacing of the knife edges under all conditions of loading and to prevent them from being loosened by the vibration incident to usage.

   Multiple weigh beams on scales to be used for weighing more than one kind of material shall have as many beams as there are different kinds of material to be weighed on the scales. All weigh beams shall be horizontal. The trig loop shall allow movement of the weigh beam above and below the horizontal position for proper operations of the telltale dial as hereinafter specified. The free end of the weigh beam shall be equipped with a suitable device for indicating clearly and accurately the horizontal position of the weigh beam.

   Provisions such as a telltale dial shall be made for indicating to the scale operator that the required load in the weighing hopper is being approached. Such a device shall indicate at least the last 200 lb (90 kg) of load.

   Poises shall be constructed so they cannot be easily removed from the beam and shall be equipped with a device to hold them firmly in place. Poises and weigh beam shall be made of non-corrosive material and shall be of sufficient hardness to prevent excessive wear.

   Graduated dials shall be provided with suitable markers placed outside the glass cover and set closely in front of the dial for use in determining the position of the dial indicator for predetermined loads in the weigh hopper. Provisions shall be made to prevent dirt from collecting in and around the dial mechanism. Means shall be provided for obtaining and maintaining proper alignment between the dial and the part of the scale which transmits the load to the dial. The dial face shall be of a material which is not affected by moisture. The value of the graduations of scales weighing 5000 lb (2250 kg) or less shall not be greater than 5 lb (2.25 kg). The value of the graduations of scales used in weighing over 5000 lb (2250 kg) shall not be greater than 0.1% of the rated capacity of the scales.

Scales shall be so constructed that they are maintained within a maximum tolerance of 0.5% of the net load in the hopper.

Clearance shall be provided between the scale parts and the hopper or bin structure to prevent displacement of or friction between the scales due to vibration or any other cause.

Each scale installation shall be provided with at least 10 standard 50 lb (eleven standard 20 kg, one standard 5 kg, and two standard 1 kg) weights, available for use at the plant at all times for checking scale accuracy. These weights shall be checked for true weight at the Engineer's discretion.

The weights shall be made of high quality cast iron and shall be cast and finished in such a manner that foreign material will not adhere to the surface.

All batching controls shall be positioned so as to allow the operator full view of all scales and admixture dispensers.

The weighing equipment, including dials, weigh beams, bins, and operating levers shall be so arranged that the Department's representatives have a clear and unobstructed view of the weighing operations at all times.

All working parts of the scales, particular knife edges, shall be protected to prevent any material, except windborne material, from falling upon or against them. Suitable windbreaks shall be constructed, when necessary, to prevent variation of the scale mechanism by winds. All working parts of the scales shall be readily accessible for inspection and cleaning.

The individual aggregates, as weighed, shall be within 1% of the required weight, and the total weight of the aggregates shall be within 1% of the required total weight.

All scales shall be checked regularly as determined by the Engineer.

3. *Water Supply.* Water shall be measured by volume or by weight. The device for the measurement of water shall be readily adjustable and shall under all operating conditions be accurate within 1% of the quantity of water required for each batch. The device shall be so arranged that the measurements are not affected by variable pressure in the supply line. Measuring tanks shall be equipped with outside taps and valves to provide for calibration unless other means are provided.

4. *Admixture Dispensers.* Equipment for dispensing air entrainment or other admixtures shall be of approved design and calibrated prior to being approved. Recalibrations will be made as required by the Engineer.

   The flasks and discharge hoses shall be transparent and so arranged that the Engineer has a clear and unobstructed view of the dispensing operation at all times.

5. *Automatic Batch Selector.* The automatic batch plant shall be controlled by means of an approved automatic batch selector set to deliver accurately, and in proper sequence, the designated weight of cement and aggregates, and the weight or volume of water and admixtures required for the concrete mixture. The batch selector controls shall be locked or sealed during the operation, and no changes in selector controls or weight settings shall be made except in the presence of the inspector.

   For safety reasons, pozzolans, if used, shall be weighed and added after the Portland cement has been weighed and added.

Provisions may be included to vary the size of the batch without affecting the basic proportions of the concrete mix being produced.

6. *Interlocks.* All batching equipment in automatic plants shall be interlocked so that a new weighing cycle cannot be started until the weigh hopper is empty, the scales are in balance, and the discharge gates and the supply valves included in the system are closed.

7. *Mixer.* The mixer shall be of approved design and shall be operated as recommended by the manufacturer. The pickup and throw-over blades shall be replaced or repaired when any part or section is worn 1" (25 mm) or more below the original height of the manufacturer's design. The mixer shall be kept free from accumulations of hardened concrete inside the mixing drum.

   The mixer shall be equipped with an approved timing device or, in the case of truck mix concrete, the use of revolution counters or other methods acceptable to the Engineer.

b. *Specific Requirements.*

1. *Central Mixed Portland Cement Concrete.*

   a. *Description.* Central mixed Portland cement concrete shall consist of Portland cement concrete manufactured from previously approved materials, proportioned and mixed in a central mixing plant and transported to the Project in approved vehicles.

   b. *Mixing.* Concrete shall be mixed in a batch mixer, as previously described, for a period of not less than 60 seconds for mixers with capacities of 10 yd; (7.65 m^3) or less. For mixers of greater capacity, the Engineer shall determine the mixing time, based on mixing efficiency. The Engineer reserves the right to adjust the mixing time to any extent necessary to obtain concrete of desired uniformity. Mixing time starts when all the materials, excluding water, are in the mixer. The batch shall be so charged into the drum that some water shall enter in advance of the aggregates and shall continue to flow for a period of not less than five nor more than ten seconds after all aggregates are in the drum. The entire contents shall be removed from the drum before succeeding batches are introduced. Unless otherwise permitted, the maximum batch size shall be the manufacturer's rated capacity for that mixer.

   c. *Moisture Meter.* An automatic electrical moisture meter, equipped with adjustable controls, shall be installed at the Engineer's discretion to measure accurately and continuously the moisture content of the fine aggregate. The meter probe shall be kept cleaned and maintained at all times.

2. *Truck Mixed Portland Cement Concrete.*

   a. *Description.* Truck mixed Portland cement concrete shall be proportioned and dry batched using previously approved materials, with water added for mixing at the plant. Delivery shall be made in approved mixer trucks. Batching and mixing shall be under the supervision of the Engineer.

   b. *Mixer Truck.* Truck mix units shall be designed for both mixing and agitation and shall be equipped with a watertight drum suitably mounted and powered, and fitted with properly designed blades. The mixing unit shall be capable of combining the aggregates into a thoroughly mixed and uniform mass of concrete and of transporting and discharging the concrete without segregation. The pickup and throw-over blades shall be replaced or repaired when any part or section is worn 1" (25 mm) or more below the original height of the manufacturer's design. The inside of the mixer drum shall be kept free from accumulations of hardened concrete.

Water supply equipment for truck mixers shall include a water storage compartment of sufficient capacity to hold mixing water for concrete and wash water required to wash the mixer after depositing concrete in all cases. The equipment shall include an external water gauge calibrated to 1 gal (5 L) intervals and suitable cut-off valves to regulate the quantity of water delivered to the mixer. These cut-off valves must be maintained in first class working order. A truck mixer with a leaky valve will not be permitted on the Project.

The size of the batch which may be charged into the truck mix unit shall not exceed the manufacturer's rated capacity for the unit when operated as a mixer. If the manufacturer's rating is not stamped on each mixing unit, the rated capacity will be determined by the Engineer. Any mixer which shows a variation in consistency of concrete of more than 1" (25 mm) slump during the discharge of any single batch shall not be permitted to operate until repaired so as to produce concrete of the required uniformity.

c. *Mixing.* Each batch of concrete mixed in truck units shall be mixed not less than 70 nor more than 100 revolutions of the mixer and at the rate of rotation specified by the manufacturer as the mixing speed. Additional mixing of more than 100 revolutions, if required, shall be done at the rate of rotation specified by the manufacturer as agitation speed. Immediately prior to the addition of water, the drum shall be operated at mixing speed. The mixing period shall be started at the time the cement and water come in contact and there shall be a minimum of 30 revolutions. This operation will be supervised by the Engineer who will indicate on the delivery ticket the time the mix started, the time that the drum is empty, and the time that the entire batch is in place.

d. *Inspection Platform.* An inspection platform of suitable dimensions and with reasonable access and safety shall be provided at the plant for the viewing of truck mix concrete by the inspector.

c. *Transportation.*

1. *Vehicle.* The vehicle in which Portland cement concrete is transported shall be an approved type of agitator truck, equipped with a watertight revolving drum, suitably mounted and powered, and fitted with properly designed blades capable of transporting and discharging the concrete without excessive abrasion and segregation

   The agitator unit shall be so constructed as to ensure rapid delivery of the concrete without loss of ingredients and to effect complete discharge of each batch.

   Low slump Portland cement concrete as used in slip-form paving may also be transported in open trucks designed for that purpose and may be either agitator or non-agitator types, provided that no segregation or loss of water detrimental to the mix, as determined by the Engineer, occurs during transportation and that the concrete delivered to the Project meets the requirements specified.

   Both agitator and non-agitator truck types shall be capable of having the dump end elevated so that the concrete will be discharged at sufficient height to permit chuting without segregation.

2. *Size of Batch.* The size of the batch which may be transported in these units shall not exceed the manufacturer's rating for the unit when used as an agitator. If the manufacturer's rating is not stamped on each mixing unit, the rated capacity will be determined by the Engineer.

d. *Portland Cement Concrete Made by Volumetric Batching and Continuous Mixing.*

1. *Description.* Portland cement concrete made by the volumetric batching and continuous mixing method is permissible for concrete used in bridge deck overlays using latex concrete, headwalls, steps, utility

encasement, manhole and inlet bottoms, gutters, curbs, headers, barrier curbs, sidewalks, island pavements, fence and sign post footings, signals, light standard and meter cabinet footings, junction boxes, and small pour items as approved by the Engineer.

2. *Mixing on the Project in a Continuous Mixing Type Truck Mixer.* Continuous mix concrete shall consist of materials accurately proportioned by volumetric measurement from bins on the truck mixer and shall be hydrated and mixed on the truck mixer at the site of the work.

   The concrete shall be mixed in an approved type mixing unit that is part of the truck carrying the dry ingredients. The mixing unit shall be an auger type mixer incorporated in the truck's discharge chute or other suitable mixing mechanism approved by the Engineer, shall produce concrete of uniform consistency, and shall discharge the mix without segregation.

   A metal plate or plates shall be attached to the truck mixer in a prominent place. The plate or plates shall be plainly marked with the gross volume of the unit in terms of mixed concrete, operating speed, and the cement constant of the mixer in terms of a revolution count required to deliver 94 lb (42.6 kg) of cement, all as rated by the manufacturer.

   The truck mixer shall be equipped with a cement bin of sufficient capacity to store and supply the quantity of dry cement required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer. The cement bin shall be free of moisture and contamination at all times.

   The truck mixer shall be equipped with aggregate bins of sufficient capacity to store separately the quantities of fine and coarse aggregates required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer. Suitable means, approved by the Engineer, shall be provided to prevent contamination or intermixing of the fine and coarse aggregates during loading and transporting. Aggregate bins shall be covered when there exists a possibility of moisture entering the bins.

   The truck mixer shall be equipped with water tanks of sufficient capacity to store the quantity of water required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer and at the slump specified for each concrete section.

   If concrete additives are to be used in the mix, suitable means, approved by the Engineer, shall be provided for storing the additives on the truck and incorporating them in the mix. Suitable means shall also be provided on the truck mixer to permit the Engineer to check the rate of flow of the additive into the mix.

   The truck mixer shall include a feeder unit mounted under the compartment bins to deliver the ingredients to the mixing unit.

   Each bin on the truck shall have an accurately controlled individual gate or feeding mechanism to form an orifice for volumetrically measuring the material drawn from each respective bin compartment. The cement bin feeding mechanism shall be set to discharge continuously and at a uniform rate a given volumetric weight equivalent of cement during the concrete mixing operation. The gates of the aggregate bins shall be calibrated at the various openings to discharge the volumetric weight equivalent of aggregate required for various concrete mixes.

   The truck mixer shall be so constructed as to allow the Engineer to check the calibration of the gate openings and meters by means of weight test samples.

   The calibration of the gate openings and meters shall be checked and certified either on a semi-annual basis or prior to work on the Contract. A copy of the Certification shall accompany the truck mixer at all times. If, at any time during construction, a piece of equipment is not performing satisfactorily, it shall be repaired satisfactorily prior to reuse.

   A 3 yd; (0.19 m^3) box constructed of suitable rigid materials shall be with the machine at all times for calibration purposes.

   Each truck mixer shall be equipped with an accurate revolution counter indicator permitting the reading of the volumetric weight equivalent of cement discharged during the concrete mixing operation.

   Each truck shall be equipped with fine and coarse aggregate dials to permit accurate adjustments of the gates of the aggregate bins for volumetric proportioning of aggregates.

Each truck mixer shall be equipped with a water meter or gauge to register the discharge rate of water by volume entering the mix.

Each truck mixer shall be equipped with positive automatic means of maintaining the operating speed of the proportioning and mixing operation independent of the drive engine of the truck, and within 8% above or below that established by the manufacturer and noted on the aforementioned metal plate as the speed at which the machine will accurately proportion concrete. Such positive automatic means shall automatically shut down the proportioning and mixing operation when the operating speed varies by more than the above tolerance. A tachometer shall be mounted on the unit to indicate the operating speed.

All indicators, dials, meters, tachometer, and controls shall be in full view and near enough to be accurately read or adjusted by the operator while mixing concrete.

Handling, measuring, and batching of materials shall conform to the applicable requirements of the Section in which the concrete is being placed.

Cement and aggregates shall be proportioned, measured, and batched by a volumetric weight equivalent method. Separate batching equipment and storage bins will not be required and the materials shall be batched in a continuous mixing truck type mixer.

The concrete will be rejected if there is any evidence of improper batching, mixing, excessive segregation, use of excessive mixing water, or if the amount of entrained air is other than as specified.

Tolerances in proportioning the various ingredients are as follows:

Cement (weight percent)	0 to +4
Fine aggregate (weight percent)	"2
Coarse aggregate (weight percent)	"2
Admixtures (weight or volume percent)	"3
Water (weight or volume percent)	"3

Each truck load of ingredients shall be accompanied by a sufficient number of delivery tickets such that the operator may supply one copy of the delivery ticket to the Engineer for each project and for each kind of concrete delivered. The delivery tickets shall show the brand name and type of cement, the calibrated cement constant of the machine in terms of the revolution indicator count, the source of aggregates, and the size of the coarse aggregate. The delivery tickets shall be signed by the mixer operator. The mixer operator shall enter on the tickets the name of the Project, the name of the Contractor, the revolution counter readings indicating the volumetric weight equivalent of cement discharged during that mixing operation, the aggregate dial settings, and the section for which the concrete is delivered. The operator shall sign each completed ticket and furnish one copy to the Engineer.

812.08 Placing and Curing. Placement and curing of portland cement concrete shall conform to the requirements of the Section for which it is being used.

SECTION 813 GRADING REQUIREMENTS MINIMUM AND MAXIMUM PERCENTAGES PASSING

Del. No.	***Sieve Size (square openings), millimeters except where noted***													
	4" (100)	*32" (90)*	*3" (75)*	*22" (63)*	*2" (50)*	*12" (37.5)*	*1" (25)*	*3/4" (19)*	*2" (12.5)*	*3/8" (9.5)*	*No. 4 (4.75)*	*No. 8 (2.36)*	*No. 16 (1.18)*	*No. 100 (150 µm)*
1	100	90 - 100		25 - 60		0 - 15		0 - 5						
2			100	90 - 100	35 - 70	0 - 15		0 - 5						
3				100	90 - 100	35 - 70	0 - 15		0 - 5					
57						100	95 - 100		25 - 60		0 - 10	0 - 5		
67							100	90 - 100		20 - 55	0 - 10	0 - 5		
8									100	85 - 100	10 - 30	0 - 10	0 - 5	
10										100	85 - 100			10 - 30

	Sieve Size (square openings), millimeters except where noted				
	3/8" (9.5)	*No. 4 (4.75)*	*No. 10 (2.00)*	*No. 40 (425 µm)*	*No. 200 (75 µm)*
"RICE"	100	70 - 100	0 - 20	0 - 10	0 - 5

SECTION 814 TIMBER PRESERVATIVES

Timber preservatives shall conform to the requirements of AASHTO M 133 and the following:

Oil-Borne Preservative. Oil-borne preservatives shall be creosote oil-tar conforming to the requirements of the AWPA preservative standards specified therein. The treatment shall consist of 12 lb/ft; (190 kg/m^3) of creosoting oil retained for other than marine environments. For marine environments, 20 lb/ft; (320 kg/m^3) of creosoting oil shall be retained. The treating shall be done according to the requirements of AWPA Standard C1, the empty-cell process.

Waterborne Preservative. Waterborne preservatives shall be CCA Type A, Type B, or Type C solutions conforming to the requirements of AWPA Standard P5. The treatment shall consist of applying CCA solution at a retention rate of 0.8 lb/ft; (13 kg/m^3) of timber for other than marine environments. For marine environments, CCA solution shall be applied at a retention rate of 2.5 lb/ft; (40 kg/m^3). The treating shall be done according to the requirements of AWPA Standard C1, the full-cell process.

Pentachlorophenol (Penta). The heavy oil type of Penta, otherwise known as Penta Type A, is the synthetic pesticide that shall be used on glulam timber for the Department's bridges. Glulam timber shall be treated with 5% Penta Type A applied at a retention rate of 0.6 lb/ft; (9.6 kg/m^3) of wood. The process involved for preservation treatment shall conform to the applicable requirements of the AWPA. Douglas fir shall be mechanically incised in accordance with the lumber industry accepted practice before preservative treatment. Once treated, the surface of the member shall not be painted nor shall it come in contact with human or animal skin.

SECTION 815 BITUMINOUS COLD-MIX (COLD-PATCH)

815.01 Description. This material consists of a uniform mixture of compatible mineral aggregate and bituminous material.

815.02 Material Requirements. Coarse aggregate shall conform to the requirements of Section 805.

Fine aggregate shall be crushed stone screenings and up to 15% washed concrete sand conforming to the requirements of Section 804. The 15% limit is based on the total dry weight of the sand compared to the total dry aggregate weight in the mixture.

Bituminous material shall conform to the requirements of Section 817. The antistripping additive shall conform to the requirements of Section 829.

The sources of all materials shall be submitted, and representative samples of the proposed bituminous material with additive and aggregate shall be provided to the Department's Materials and Research Section.

Material shall not be produced for the Contract, nor any mixture accepted, until the proposed job mix formula has been approved by the Department's Materials and Research Section. The producer shall submit a written proposal indicating the single definite percentage of each sieve fraction of aggregate and percentage of asphalt residue. Expected temperature ranges for component materials and the completed mixture shall also be provided with the job mix formula submission.

The job mix formula shall be within the following limits, however, the Department's Materials and Research Section reserves the right to make adjustments to the formula:

Sieve Size	***Percent Passing***	***Production Tolerance (")***
3/8" 9.5 mm	100	0
No. 4 (4.75 mm)	55 - 90	7
No. 8 (2.36 mm)	10 - 40	4
No. 200 (75 Fm)	0 - 3	2

Asphalt residue, including additive, shall be 4.5 to 6.5% of the total aggregate weight. When tested according to procedures described herein, the allowable production tolerance from the approved mix design is "0.4%.

Note: There is a substantial difference between "% residue by volume" and "% residue by weight". The Department's Materials and Research Section can assist the producer in determining the proper amount of bituminous material to add to meet the job mix asphalt residue target.

815.03 Mixing Methods. The aggregate shall be heated to a temperature between 185 and 225 ºF (85 and 107 ºC), and the asphalt shall be heated to a temperature between 135 and 175 ºF (57 and 79 ºC). The completed mix shall have a temperature not to exceed 180 ºF (82 ºC).

The proposed mixing facility shall be approved by the Department's Materials and Research Section for mixing these materials. Any type mixer other than a batch type mixer will be approved for use only after careful evaluation of the mixing capabilities.

The producer shall notify the Department's Materials and Research Section of the mixing schedule at least one full working day before any mixing.

Mixing shall be continuous until all aggregates are thoroughly coated with the bituminous material.

815.04 Acceptance of Materials. Samples of the component materials and the produced mixture shall be provided to the Department's Materials and Research Section in order to test the materials' qualities. Acceptance of the materials and the produced mixture will be based on an evaluation of asphalt-aggregate compatibility using a boiling strip test and a coating test, and extraction analysis of the mixture

815.05 Performance Requirements. The aggregate shall be uniformly coated with no stripping of the bituminous material from the aggregate. The mixture shall be capable of being stored in a stockpile for a period of at least six months without hardening or striping and shall remain workable during all expected weather conditions during this storage.

SECTION 816 POLYMER MODIFIED BITUMINOUS COLD-PATCH MATERIAL

816.01 Description. The polymer modified bituminous cold-patch material shall be a uniform mixture of compatible mineral aggregate and a polymer modified cutback asphalt. The aggregate shall be uniformly coated with no stripping of the bituminous material from the aggregate. The mixture shall be capable of being stored in a stockpile for a period of at least six months without hardening or stripping and shall remain workable during all expected weather conditions during this storage.

816.02 Submission and Approval. Written documentation of current approval by the supplier of the bituminous material of the mix design and the proposed mixing facility must be submitted to and approved by the Department's Materials and Research Section prior to production.

816.03 Material Requirements. The aggregate shall be clean, crushed limestone or stone of equal quality, free from any foreign or deleterious material.

The polymer portion of the polymer modified cutback asphalt shall be blended with a cutback asphalt. The formulation shall be at the discretion of the manufacturer. The polymer modified cutback asphalt shall be piped directly from the transporting tanker into the mixing plant without an intermediary holding tank.

816.04 Job Mix Formula. It is the responsibility of the producer to submit a written proposal indicating the single definite percentage of each sieve fraction of aggregate and percentage of asphalt residue. Expected temperature ranges for component materials and the completed mixture shall also be provided with the submission.

The polymer modified cutback asphalt shall be added at a rate of 5.25 to 6.25% by weight, with an allowable production tolerance of "0.4% based on the total weight of the mix.

816.05 Mixing Requirements. The mixing facility must be a batch type mixer. Any type other than a batch type mixer will be approved for use only after careful evaluation of its mixing capabilities. All aggregate must be free of excess surface moisture prior to mixing. If some drying is required, heating must not exceed 150 ºF (66 ºC). Mixing shall be continuous until all aggregates are thoroughly coated with the bituminous material. After mixing, the material shall be stockpiled for a minimum of 48 hours in order to allow curing to occur. During this period of time, the stockpile will be examined for runoff and workability.

816.06 Performance Requirements. Samples of the component materials and the produced mixture will be obtained by the Department's Materials and Research Section in order to test their qualities. Acceptance of the materials and the produced mixture will be based on, but not necessarily totally on, the following described tests and considerations:

Coating Test

Extraction Analysis

Boiling Strip Test

The initial approval of the material sources, mix design, plant facilities, or mixture based on the above tests shall in no way preclude further examination and testing if unsatisfactory results or performance are encountered. The acceptance at any time shall not bar future rejection. Performance will be judged at the time of materials use.

SECTION 817 CUT-BACK ASPHALTS

Cut-back asphalts shall conform to the requirements of AASHTO M 81 for rapid curing (RC) types and AASHTO M 82 for medium curing (MC) types.

In addition, medium curing (MC) types shall conform to the following requirements:

Test	***Minimum***	***Maximum***
Kinematic Viscosity at 140 ºF (60 ºC), m5/s	0.0004	0.0008
Flash Point, Tag Open Cup, ºF (ºC)	66	---
Water, %	---	0.2
Distillation Test	***Minimum***	***Maximum***
Distillate, percentage by volume		
to 437 ºF (225 ºC)	*0*	*7*
to 500 ºF (260 ºC)	*10*	*45*
to 600 ºF (315 ºC)	*55*	*85*
Residue from Distillation to 680ºF (360 ºC), volume percentage of sample by difference	*70*	---
Tests on Residue	***Minimum***	***Maximum***
Absolute Viscosity at 140 ºF (60 ºC), Pa@s	*30*	*120*
Ductility 5 cm/min. at 77ºF (25 ºC), cm	*100*	---
Solubility, %	*99*	---

SECTION 818 MORTAR SAND

Mortar sand shall conform to the requirements of AASHTO M 45 and the following grading:

Sieve Size	***Percent Passing***
No. 4 (4.75 mm)	100
No. 8 (2.36 mm)	95 - 100
No. 100 (150 Fm)	0 - 25
No. 200 (75 Fm)	0 - 10

*Fineness Modulus:*1.6 to 2.5

The organic impurities requirement will be waived for uses other than masonry mortar.

SECTION 819 SOLID CONCRETE BLOCK

Solid concrete block shall conform to the requirements of ASTM C 139, except that absorption shall have a maximum value of 15 lb/ft; (240 kg/m^3). Units less than 5" (125 mm) in thickness shall have a minimum compressive strength of 2000 psi (15 MPa). A concrete masonry unit may be either a concrete block or what is commonly referred to as a concrete brick.

SECTION 820 COATINGS FOR STEEL STRUCTURES

820.01 Description. This material consists of the designated systems of coatings for steel structures. If no system is designated, the material shall conform to the requirements of Subsection 820.02 (a).

820.02 Material Requirements.

Inorganic Zinc-Epoxy Urethane System. Individual coats shall consist of an inorganic zinc-rich primer conforming to the requirements of AASHTO M 300, Type I or II; an epoxy-polyamide intermediate coat conforming to the requirements of SSPC-Paint 22 (pigmented to contrast with both the primer and topcoat); and an aliphatic urethane topcoat conforming to the requirements of SSPC-PS Guide 17.00, Type II. The topcoat color of the structural steel shall match color chip No. 24172 (green) of FED-STD-595B, unless otherwise indicated on the Plans.

Moisture-Cured Urethane System. All paint used on any one structure shall be produced by a single manufacturer; and the coating system shall conform to the minimum requirements as noted below.

Primer

Generic Type:	Micaceous Iron Oxide/Zinc-rich, single-component, moisture-cured polyurethane
Vehicle Type:	Moisture-cured polyurethane
Volume of Solids:	60% minimum
Pigment Type:	Micaceous Iron Oxide/Zinc dust
Coverage:	3 mils (75 μm) DFT minimum
VOC:	Not to exceed 2.84 lb/gal (0.34 kg/L)
Weight:	Minimum 19.00 lb/gal (2.28 kg/L)

Intermediate Coat

Generic Type:	Micaceous Iron Oxide-filled, single-component, moisture-cured polyurethane
Vehicle Type:	Moisture-cured polyurethane
Volume of Solids:	60% minimum
Pigment Type:	4.00 lb/gal (0.48 kg/L) Micaceous Iron Oxide, tinted to distinguish from primer and topcoat
Color:	Tinted to distinguish from primer and topcoat
Coverage:	3 mils (75 μm) DFT minimum
VOC:	Not to exceed 2.84 lb/gal (0.34 kg/L)
Weight:	Minimum 16.00 lb/gal (1.92 kg/L)

Finish Coat

Generic Type:	Micaceous Iron Oxide-filled, single-component, moisture-cured polyurethane
Vehicle Type:	Moisture-cured polyurethane
Volume of Solids:	60% minimum
Pigment Type:	3.50 lb/gal (0.42 kg/L) Micaceous Iron Oxide
Finish:	Flat (low gloss)
Color:	To be specified in the Plans
Coverage:	3 mils (75 μm) DFT minimum
VOC:	Not to exceed 3.00 lb/gal (0.36 kg/L)
Weight:	Minimum 16.00 lb/gal (1.92 kg/L)

Each single coat of paint shall be a color different from the others. The color of the primer and intermediate paint shall be at the Contractor's option and shall provide contrast with the underlying substrate or previously applied paint. The color of the finish paint shall be as specified in the Plans.

Successive time interval for coating in between prime coat, intermediate coat, and finish coat shall be a minimum of four and a maximum of 14 days. If the Contractor fails to complete the painting during the established period, the surface are shall be cleaned if necessary as determined by the Engineer.

The Contractor may use one of the following approved paint systems:

1. *Wasser High-Tech Coatings, Kent, WA 98032*

   Primer: Wasser MC-MIO Zinc (spot) [3 mils (75 μm), DFT]
   Intermediate: Wasser MC-Miomastic Iron Oxide [3 mils (75 μm), DFT]
   Finish: Wasser Ferrox A [3 mils (75 μm), DFT]

2. *Xymax Coatings, Inc., Oakland, FL*

   μm), DFT]
   Intermediate: Mono-Ferro [3 mils (75 μm), DFT]
   Finish: Bridge Finish [3 mils (75 μm), DFT]

All components of the system (primer, intermediate, and finish coats) will be accepted on the basis of the manufacturer's written certification that the batch(s) produced meets their product specification.

Only paint arriving at the work site in new, unopened containers shall be used.
Containers of paint shall be labeled with the manufacturer's name, product name, component part, batch number, date of manufacturer, and shelf life date. Paint in containers having expired shelf life dates shall be immediately removed from the work site.

c. *Moisture-Cured Aluminum System.* The moisture-cured aluminum paint must follow the following requirements:

One-Coat System

Generic Type:	Aluminum filled aromatic moisture-cured urethane
Vehicle Type:	Moisture-cured aromatic polyurethane
Pigment Type:	Minimum 2.00 lb/gal (0.24 kg/L) non-leafing aluminum
Coverage:	2 mils (50 µm) DFT minimum
VOC:	Not to exceed 3.50 lb/gal (0.42 kg/L)
Weight:	9.2 lb/gal (1.1 kg/L)
Volume of Solids:	52.0 " 1.0%
Shelf Life:	Six months from date of shipment, in unopen original containers stored at temperatures below 86EF (30 EC).

SECTION 821 GRADED AGGREGATES

821.01 Description. This material consists of coarse crushed stone, crushed slag fragments or portland cement concrete fragments blended with crushed particles of the same origin.

821.02 Applicable Testing Methods.

AASHTO T 2

AASHTO T 27

AASHTO T 96

821.03 Material Details.

a. *Submissions.* Samples from the source of the material shall be supplied as directed by the Engineer.

b. *Material Properties.* The graded aggregate blend shall be uniform in quality and free of silt, clay, decomposed fragments, overburden material, soil, reinforcement, and other deleterious debris.

c. *Gradation.* Graded aggregate material shall conform to the following gradation requirements for the appropriate type:

WEIGHT PERCENTAGE PASSING

Sieve Size	***Type A (CR-1)***	***Type B (Crusher Run)***
2 1/2" (63 mm)	100	---
1 1/2" (37.5 mm)	---	100
1" (25.0 mm)	50 - 80	---
3/4" (19.0 mm)	---	50 - 95
No. 4 (4.75 mm)	20 - 50	20 - 50
No. 10 (2.00 mm)	---	15 - 40
No. 20 (850 Fm)	10 - 30	---
No. 100 (150 Fm)	2 - 20	2 - 20

The percentage of wear as determined by the Los Angeles machine shall not exceed 45%.

SECTION 822 FLY ASH

822.01 Description. This material consists of fly ash, which is a by-product of coal combustion. Fly ash may be used as a mineral additive in concrete and as a partial replacement for Portland cement within Section 812 and other Sections of these Specifications.

822.02 Materials Requirements. Fly ash shall conform to the requirements of AASHTO M 295, Class C or F as modified herein. The requirements of Table 1 "Chemical Requirements" shall be modified to establish the maximum "Loss on Ignition" at 4.0%. Table 2 "Supplementary Optional Chemical Requirement" and Table 4 "Supplementary Optional Physical Requirements" shall apply. In Table 3 "Strength Activity Index" the minimum activity index at seven days shall be 85% of the control and the minimum at 28 days shall be 100% of the control. Traces of ammonia and oil shall be absent from the fly ash.

Transport containers for fly ash shall be of a design that provides for proper and complete unloading. Dedicated and reserved storage bins of fly ash shall be sampled and tested by the Engineer. All tests shall be completed and shall show that the material conforms with all requirements prior to any use.

Upon approval of the Engineer, the preceding requirement for dedicated and reserved storage bins of fly ash may be waived if the fly ash supplier is qualified for inclusion in a certification program. The Program of Certification involves acceptable supplier quality control procedures.

For an acceptable Program of Certification, the supplier must establish a history of satisfactory quality control of fly ash produced as evidenced by the results of tests performed by the Department and the supplier's testing laboratory. The supplier shall conduct sufficient tests to ensure that adequate quality is maintained in regard to the material specifications. The supplier must maintain a record of all tests for review by the Engineer. The Engineer reserves the right to modify the program as considered necessary to maintain quality. Samples for tests by the Department may be taken at any time as determined by the Engineer. In addition, the handling and storage facilities must be approved by the Engineer.

SECTION 823 HOT-MIX, HOT-LAID BITUMINOUS CONCRETE

823.01 Description. This material consists of hot-mix, hot-laid bituminous concrete bases and surface courses.

MATERIALS.

823.02 Asphalt Cement. The asphalt cement shall be AC 20 with a viscosity grade conforming to the requirements of Section 810. Tank trucks used to deliver asphalt cement shall be equipped with an approved sampling device. The delivery temperature of the material shall not exceed the maximum mixing temperature.

823.03 Fine Aggregate. Fine aggregate is defined as all material passing the No. 8 (2.36 mm) sieve and shall consist of clean, hard, durable crushed stone.

In Job Mix Formula Types B, C, and D, which are defined in Subsections 823.19, 823.20, and 823.21, up to 15% of the fine aggregate may be washed concrete sand, conforming to the requirements of Section 804. If the stability, as determined by the Laboratory Marshall Method in accordance with AASHTO T 245, is less than 1200 lb (5.3 kN), the fine aggregate sand percentage shall be reduced or excluded. All carbonate and serpentine aggregate shall be prohibited in the final roadway wearing surface course on any roadway having a minimum average daily traffic volume (ADT) of 8000 vehicles and a posted speed of 35 mph (60 km/h) or greater.

823.04 Coarse Aggregate. Coarse aggregate shall be all material retained on the No. 8 (2.36 mm) sieve and shall conform to the requirements of Section 805. All carbonate and serpentine aggregate shall be prohibited in the final roadway wearing surface course on any roadway having a minimum average daily traffic volume (ADT) of 8000 vehicles and a posted speed of 35 mph (60 km/h) or greater.

823.05 Antistripping Additive. When specified for use by the Engineer, or when the Tensile Strength Ratio (TSR) is less than 80 as determined in accordance with AASHTO T 283, a heat-stable, antistripping chemical additive conforming to the requirements of Section 829 shall be blended with the asphalt cement in accordance with Subsection 823.16.

823.06 Laboratory. At all batch and dryer drum mixing plants, the Contractor shall provide a building suitable for a field laboratory in which to house and use the equipment necessary to carry on the various tests required, including bituminous extractions and gradations.

The building shall be for the use of the Engineer and inspectors for testing and recording purposes and shall be so located that activities at the plant are plainly visible from one window of the building.

The building shall have a minimum of 600 ft5 (55 m^2) of floor space and be of acceptable dimensions. It shall be weatherproof and have at least two windows and a door, all equipped with acceptable latches and locks. The building shall be maintained to the satisfaction of the Engineer. Satisfactory lighting, heating, and air conditioning shall be supplied. The air conditioning equipment shall be capable of maintaining the room temperature throughout the laboratory at 77 º (25 ºC) at all times.

The Contractor shall furnish all water, including drinking water, fuel, telephone, heat, and power to conduct all necessary tests. Tables, desks, chairs, and work tables shall be provided and maintained as required. Approved sanitary facilities shall be furnished and maintained.

If approved, the laboratory may be a part of another building, in which case it shall be completely partitioned off from the remainder of the building.

823.07 Testing Equipment. All production plants shall be equipped with all the necessary equipment from the equipment list supplied by the Department's Materials and Research Section. The Contractor shall ensure that the laboratory contains equipment of approved make and design and shall maintain the equipment to the satisfaction of the Engineer.

Approval of the plant will be contingent upon meeting the requirements of Subsection 823.06 and this Subsection.

823.08 Inspection of Mixing Plant Operations. The Engineer or the Engineer's representative shall have access at all times to all parts of the mixing plant for checking the adequacy of the equipment in use, inspecting the conditions and operation of the plant, verifying the weights or proportions and character of materials, and determining and checking the temperatures being maintained in the preparation of the mixtures.

MIXING PLANTS.

The two types of mixing plants are Batch Type and Continuous Mixing Type.

823.09 Batch Type. Bituminous concrete plants will not be approved unless they are automated.

The automatic batch plant shall be controlled by means of an approved automatic batch selector. The batch selector shall control and deliver, accurately and in proper sequence, the designated weight or volume of bituminous material and aggregates required for the bituminous concrete mixture and shall automatically time the mixing operation. The batch selector controls shall be locked or sealed during the operation, and no changes in selector control or setting shall be made except in the presence of the Engineer's representative.

a. *Interlocks.* The plant shall be equipped with interlocking cut-off circuits to interrupt and stop the automatic cycling of the operation at all times when errors in weighing or proportioning occur, or when there is a malfunction of any portion of the control system.
b. *Equipment Failure.* If the automatic proportioning devices become inoperative, the plant may be permitted to batch and mix bituminous materials for a period of not more than 48 hours from the time of the breakdown, if approved by the Engineer. Written permission of the Engineer shall be required for a period of operation longer than 48 hours without automatic proportioning.

823.10 Plant and Machinery. The mixing plant used by the Contractor in preparation of the bituminous concrete shall be capable of producing a minimum of 75 tons (68 metric tons) per operating hour and shall comply with the following requirements:

a. *Cold Feed.* The plant shall be provided with a separate cold bin or tunnel opening for each size and type of mineral aggregate used in the mix. In addition, each cold bin or tunnel opening shall be equipped with a calibrated gate and mechanical feed to provide a uniform and concurrent flow of aggregates prior to their introduction into the drier.
b. *Drier.* The drier shall be a rotating cylinder type suitably designed to heat and dry the aggregates, and shall continually agitate the aggregates during heating. The drier shall be capable of preparing aggregate to the full rated capacity of the paving plant.
c. *Burner.* The burner shall be of an approved design and shall be automatically controlled.
d. *Sieves.* All plant sieves shall be designed, constructed, and operated so that all aggregates are sieved to their specified sizes and proportions, and shall have a capacity, when operated at normal speed, slightly in excess of the maximum capacity of the mixer.
e. *Bins.* The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to ensure separate and adequate storage of appropriate fractions of the mineral aggregates, and the plant shall be equipped to feed such material into the mixer within "0.5% of the total batch weight. Separate dry storage shall be provided for filler or hydrated lime when used, and the plant shall be equipped to feed such material into the mixer within "0.5% of the total batch weight. Each bin shall be provided with overflow pipes, sized and located to prevent material backing up into other compartments or bins. Each compartment shall be provided with an individual outlet gate that prevents leakage when closed. The gates shall cut the flow off quickly and completely. Bins shall be constructed so that samples can be readily obtained. Bins for continuous mix plants shall be equipped with adequate telltale devices to indicate the position of the aggregates in the bins at the lower quarter points. Each compartment shall be designed to prevent the overflow of material into other bins.
f. *Weigh Box or Hopper.* The plants shall have a weigh box of sufficient capacity to hold the maximum amount of the aggregate material for one batch. The weigh box or hopper shall be supported on fulcrums and knife edges, and constructed such that it can not be easily thrown out of alignment or adjustment. Weighing hoppers must be free from contact with all edges, ends, sides, supporting rods or columns, or with other equipment that will in any way affect their proper functioning. In addition, there must be sufficient clearance between the hopper and supporting devices so that foreign materials will not accumulate. The discharge gate of the weigh box must be positioned to prevent aggregate separation when dumping in the mixer. If necessary, baffles shall be inserted or other means provided to discharge the materials in a blended condition.
g. *Aggregate Scales.* Scales for the weighing of aggregates shall be of standard make and design and shall be accurate to 0.5% throughout their range. The scale shall consist of a digital readout connected to a load cell. All digital readouts shall be so located that they will be in plain view of the operator and the Engineer or the Engineer's agent. No weighing of aggregates shall be permitted where vibration from the plant mechanisms or any other source prevents accurate reading of the scale. The value of the gradations of scales weighing over 5000 lb (2250 kg) shall not be greater than 0.1% of the rated capacity of the scale.
h. *Bitumen Scales.* The digital scale shall have a capacity of at least 15% in excess of the quantity of bituminous material used in a batch. The controls shall be constructed so that they may be locked at any setting and automatically reset to the reading after the addition of bituminous material to each batch. The readout shall be in full view of the mixer operator and the Engineer and the Engineer's agent and shall be graduated in increments not greater than 1 lb (0.45 kg). The flow of bituminous material shall be automatically controlled. All of the bituminous material required for one batch shall be discharged in not more than 20 seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

   The equipment used to measure the bituminous material shall be accurate to "0.5%. The bituminous material bucket shall be a non-tilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be adequately heated. The capacity of the bituminous material bucket shall be at lease 15% in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated, quick acting, non-drip, charging valve located directly over the bituminous material bucket.
i. *Test Weights.* The Contractor shall provide and have readily available at least 10 standard 50 lb weights (eleven standard 20 kg, one standard 5 kg, and two standard 1 kg weights), for checking the scales during operations.

   The weighing equipment, in addition to complying with the above requirements, must have adjusting devices which will provide for the readjustment of any part that, being out of adjustment or balance, prevents the scale from functioning properly.
j. *Asphalt Control System.* The proper amount of bituminous material in the mix, within the tolerance specified for the job mix, shall be provided by either weighing or metering.

Heating of asphalt cement shall be by steam coil, hot oil, or other approved methods. Under no circumstances shall a flame from oil or other fuel be permitted to come in direct contact with the heating tanks. The asphalt circulating system shall be sized to give proper and continual circulation of asphalt cement throughout the operating periods.

k. *Thermometric Equipment.* An armored thermometer, reading within the ranges used, shall be fixed in the asphalt line at a suitable location near the weigh bucket discharge valve.

   The plant shall also be equipped with an approved dial scale thermometer and an electric pyrometer or other approved thermometric instrument placed at the discharge chute of the drier to automatically register and record the temperature of the heated aggregates. This device shall also be in full view of the burner controller or the head feeder.

   The Engineer reserves the right to judge the efficiency of the above instruments and direct the replacement of the instruments with some approved temperature recording apparatus. Further, the Engineer may require the Contractor to submit daily charts of the recorder's readings.

l. *Mixer Unit.* The mixer shall be a heat-jacketed, insulated, batch mixer, of the standard pugmill type, or an approved heat-jacketed, insulated, rotary drum-type mixer. Rotary mixers shall be equipped with a sufficient number of paddles or blades set in position to produce properly mixed batches of any material required under these Specifications. When the clearance in the twin pugmill exceeds 1" (25 mm), either the shortened blades or the worn liners (or both) shall be replaced to reduce the clearance to less than the allowable 1" (25 mm) maximum. The mixer shall be provided with an approved, accurate time lock that will lock the discharge gates until the specified mixing time has elapsed. In no case shall the rated capacity of the mixer specified on the manufacturer's name plate be exceeded. If sufficient mixing and coating is not obtained, the Engineer reserves the right to direct the Contractor to increase the mixing time.

   Deviations in sizes of batches will be permitted to provide for mixing batches 25% below the rated capacity of the mixer. When slag coarse aggregate is used, no increase will be permitted in the size of the batch above the rated capacity of the mixer.

m. *Dust Collector.* All plants shall be equipped with an approved dust collector system. Provisions shall be made to waste the collected material or to return it uniformly to the aggregate mixture as directed. All State and local air pollution control regulations and ordinances shall be followed.

n. *Safety Requirements.* An adequate and safe stairway to the mixer platform and guarded ladders shall be placed at all points required for accessibility to all plant operations. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading space, and this space shall be kept free of drippings from the mixing platform. A platform shall be located at the truck loading space to permit easy and safe inspection of the mixture as it is delivered into the trucks. The platform and steps shall have safety handrails. Easy and safe access shall be provided to the location above the mixer where sampling of the aggregate in the bins is to take place. Adequate overhead protection shall be provided where necessary. All other Federal, State, or local safety requirements shall be followed.

o. *Platform Truck Scales.* All plants shall be equipped with platform truck scales to weigh empty and loaded trucks. Truck scales shall be of approved design and kept in good condition. Scales shall be mounted in a concrete foundation that will ensure their remaining level and plumb. Scales shall be mounted to weigh the entire truck. All platform truck scales shall be approved by the appropriate Sealer of Weights and Measures and have seals attached at the beginning of each season or at such other times, as may be deemed necessary. Manufacturer's Certified Scale Checks may be accepted. Split weighing will not be approved.

823.11 Continuous Mixing Type. The use of continuous mixing plants will be permitted for the preparation of hot-mix bituminous concrete, provided such plants conform to the requirements listed below and to the general requirements for all plants.

a. *Gradation Control Unit.* The plant shall include a means for accurately proportioning each size of aggregate by either weighing or volumetric measurement. When gradation control is by volume, the plant shall include feeders mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to provide an orifice for volumetrically measuring the material drawn from each bin compartment. The orifice shall be rectangular with one dimension adjustable by a positive mechanical means, and shall be provided with a lock. Indicators shall be provided in each gate to show the gate opening in millimeters.

   Mineral filler, if specified, shall be proportioned separately and added to the mix to obtain uniform distribution.

b. *Weight Calibration of Bitumen and Aggregate Feed.* The plant shall include a means of calibrating gate openings and meters using weight test samples. The aggregate fed out of the bins through individual orifices shall be bypassed to a suitable test box, confining the material from each compartment in a separate box. The plant shall be equipped to conveniently handle test samples weighing up to 800 lb (360 kg) and to weigh them on accurate scales. Means shall be provided for calibrating the flow of bitumen.

c. *Synchronization of Aggregate and Bitumen Feed.* Positive interlocking control between the flow of aggregate from the bins and the flow of bitumen from the meter or other proportioning source shall be provided. This device shall include a mechanical interlock or other positive method of accurate control.

d. *Mixer Unit Continuous Method.* The plant shall include a continuous mixer of an approved twin pugmill type, heat-jacketed, and capable of producing a uniform mixture within the permissible variations from the job mix specifications. The angular position of the paddles on the shafts shall be adjustable, and the paddles shall be reversible to retard the flow of the mix. The mixer shall carry a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge and the rate of feed of aggregate per minute at plant operating speed.

   Unless otherwise required, determination of mixing time shall be by the weights method under the following formula. The weights shall be determined for the job by tests made by the Engineer

   Mixing Time (s) =

   Pugmill Output In Pounds per Second (kg/s)

   The production capacity of the continuous mix plant shall be not less than 75 tons (70 metric tons) per hour 42 lb/s (19 kg/s).

e. *Discharge Hopper.* The discharge end of the pugmill shall be equipped with a hopper, or other approved device for truck loading, that will eliminate segregation of the mixed material.

PROCEDURE FOR BATCH OR CONTINUOUS TYPE PLANTS.

823.12 Preparation of Asphalt Cement. All asphalt cement shall be uniformly heated in tanks to a temperature of 250 to 350 ºF (120 to 175 ºC). Asphalt shall be maintained within these temperature limits.

823.13 Preparation of Mineral Aggregates. Before entering the mixer, the aggregates shall be dried and heated to a temperature of not more than 375 ºF (190 ºC), except for recycled mixes. Flames used for drying and heating shall be properly adjusted to avoid injury to the aggregate.

Immediately after heating, the aggregates shall be screened into separate bins, ready for batching and mixing with asphalt cement.

823.14 Preparation of the Mixture. Each size of hot aggregate and the asphalt cement shall be weighed separately to accurately determine the correct portion of each constituent in the mix. The mixing temperature and tolerance will be given by the Department's Materials and Research Section for the type of material being produced.

The mixture shall consist of coarse aggregate, fine aggregate, mineral filler if required, and asphalt cement. The exact proportions within the limits specified shall be regulated to produce a satisfactory non-boiling mixture with all the particles fully coated.

After the hot fine and coarse aggregates are introduced into the twin pugmill, a minimum dry mix time of 6 seconds shall be required unless otherwise directed by the Engineer. The asphalt cement shall be added in an even sheet the full width of the mixing chamber. After the asphalt cement is added, mixing shall be continued for a minimum of 30 seconds, or until the aggregates are coated and well mixed.

The processed bituminous concrete mixture may be held in an approved storage system in accordance with Subsection 823.17.

823.15 Dryer-Drum Mixers. The plant shall be specifically designed for dryer-drum mixing and shall be capable of satisfactorily heating, drying, and mixing the bituminous mixtures. The aggregate shall enter the drum from the burner-end and shall travel parallel to the flame and the exhaust air stream. The system shall be equipped with automatic burner controls. Heating shall be controlled to prevent damage to the aggregate or the asphalt cement. The temperature of the mixture when discharged from the mixer shall be within the range specified by the Department's Materials and Research Section for the type mix being produced. The rate of flow through the drum shall be controlled to obtain a homogeneous mixture with uniformly-coated particles. In no case shall the quantity of mixture produced exceed the manufacturer's rated capacity.

Each cold feed bin shall have an adjustable gate with an indicator to reference the opening setting. A device shall be installed on each of the aggregate feeders to indicate when the flow of material from the bin is not sufficient to allow accurate proportioning through the feeder gates. These indicators shall be positive in action and shall actuate a clearly visible or audible signal to attract the plant operator's attention, and they shall stop the flow of materials to the drum when the level of material in the bin is too low for accurate proportioning. In addition, for those particular cold bins in which aggregate material tends to either bridge or lump together causing temporary interruptions in feeds, a vibrator or other suitable means shall be provided to ensure uniform flow out of bins so that aggregate material does not bridge or lump. All cold feed bins including mineral filler silos shall be accurate to 0.5% of the total weight delivered by that particular bin or silo. The order of aggregate feed onto the composite cold feed belt shall be from coarse to fine. An independently mounted scalping screen shall be installed if directed by the Engineer.

Asphalt cement shall be introduced through a continuously registering, cumulative indicating meter by a pump specifically designed for dryer-drum plants. The meter shall be located in the asphalt line to continuously register the asphalt discharge to the mixer and arranged to allow diversion of the discharge through the meter to a container for measurement. The meter shall be equipped with a nonsetback register and shall have an accuracy within 1% by weight of the material actually being measured in any given period of time. The temperature of the asphalt shall be monitored by a thermocouple which shall be calibrated prior to the annual asphalt feed calibration to within 4 EF (2 EC) of a certified mercury thermometer and shall have a digital display on the control panel. The accuracy of the pump and meter shall be verified annually and whenever designated by the Engineer with the Engineer's agent present to document the calibration.

The aggregate feed and the asphalt flow systems shall be interlocked by a blending system that automatically regulates the asphalt flow and immediately corrects for variations in aggregate flow. The system shall provide positive weight measurement of the combined cold aggregate feed by use of a belt scale. The combined cold aggregate feed shall be continuously recorded on a nonsetback register. Feed of material to the belt scale shall be controlled to ensure that the combined aggregate flow is between 50 and 100% of the rated capacity of the scales at normal operation. The plant shall be equipped so that the proportion of each aggregate can be individually varied. The plant shall also be equipped so that the total aggregate rate can be varied without affecting the proportions. The plant shall be equipped with a moisture compensating device in the control panel to automatically correct for the moisture in the aggregate passing over the belt scale. The plant shall be required to use the most recent moisture values obtained to ensure accurate asphalt proportioning. Moisture determinations for the combined aggregate will be made periodically during each day's operation. The plant shall also be equipped with a device in the control panel to automatically correct for the specific gravity of the asphalt.

Safe, adequate, and convenient facilities shall be provided for obtaining representative asphalt and aggregate samples. The plant shall be equipped with a sampling device capable of providing a sample of sufficient size from the full width of the combined aggregate cold feed flow. The sampling device shall be designed so that samples may be taken while the plant is operating at normal production rates. Safe, adequate, and convenient facilities shall be provided for calibrating the asphalt flow and the aggregate flow. The manufacturer's recommendations shall be followed for calibration. To calibrate the aggregate flow system, means shall be provided to permit a positive and uniform diversion of the aggregate in sufficient quantity to accurately check the weight of aggregate per period of time. To calibrate the asphalt metering system for proper proportioning, an asphalt distributor or other equipment approved by the Engineer shall be made available so that accurate tare, gross, and net weights may be obtained for the diverted asphalt discharge. The rate of flow of the total aggregate and asphalt flow shall not vary by more than 2.0% by weight from the required quantity of each.

The dryer-drum mixer shall be capable of simultaneously heating and mixing the introduced aggregate and asphalt to produce an acceptable, thoroughly coated mix meeting the required temperature and mix designs. Pyrometers or other thermometric instruments shall be located at the discharge chute of the dryer-drum mixer to automatically register the temperature of the mix.

Prior to mixing of hot-mix bituminous concrete in drum mix plants, the gradation of all stockpiled aggregate material shall be checked for grading requirements conforming to Section 813 and shall be approved prior to use. Aggregate from the approved stockpiles shall be selected based on a percentage of the stockpile sizes to meet the appropriate job mix formula gradation according to Subsections 823.20, 823.23, and 823.24. Samples from the cold feed conveyor shall be taken to ensure that the proper gradation requirements are being met prior to the addition of asphalt for production of hot-mix.

823.16 Anti-stripping Additive Blending - All Plants. Blending of the additive and asphalt cement shall be accomplished at the bituminous concrete production plant during the production of bituminous material, through the use of an approved in-line metering and blending system. The holding tank shall be thermostatically controlled for heat and shall have a re-circulating line for uniform heat control. The additive temperature shall be maintained at a uniform mix temperature at least 24 hours prior to production to ensure uniform additive viscosity. There shall be a diverter valve in the re-circulating line from the pump for calibration purposes, which shall deliver a full stream from the additive pump at a height equivalent to the addition input to the main asphalt line. Additive pumps shall be calibrated on a daily basis or whenever deemed necessary by the Engineer. The calibration shall be done by plant personnel and witnessed by a representative of the Department's Materials and Research Section.

823.17 Storage Systems - All Plants. The system shall be capable of conveying the hot-mixture from the plant to the storage bins and storing the hot-mixture without a reduction in temperature and with no segregation of the mix or oxidation of the asphalt. The mixture, as delivered for the work, shall comply with all specified quality requirements.

The conveyor system may be either a continuous or skip bucket type. The continuous type shall be enclosed and heated to effectively control the mix temperature. The skip bucket type must be large enough to transport and mass dump an entire batch into the bins.

The storage bins shall be designed to prevent segregation of the mix during discharge from the conveyor into the bins. The bin discharge gates shall be designed to prevent segregation of the hot-mixture while loading into trucks.

Approval for the use of storage bins may be withdrawn when excessive heat gain or loss, uneven heating, segregation of the aggregate, or migration or oxidation of the asphalt occurs due to the operation or use of storage bins. Mixtures may be retained in heated storage bins for 12 hours, provided that material and mixture qualities are maintained.

MIXTURE REQUIREME'TS.

823.18 Applicable Testing Methods. The following standards shall be used to test the qualities of the mixture.

AASHTO T 164	Method A, Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
AASHTO T 166	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
AASHTO T 209	Maximum Specific Gravity of Bituminous Paving Mixtures
AASHTO T 245	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
AASHTO T 269	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
AASHTO T 283	Resistance of Compacted Bituminous Mixture to Moisture Induced Damage
AASHTO T 287	Asphalt Cement Content of Asphalt Concrete Mixtures by the Nuclear Method

Samples of the actual mixture in use will be taken as many times daily as determined by the Engineer. The mixture must be maintained uniform throughout the Project within the above tolerances. Should the mix produced not meet the above requirements or the Contract performance needs, changes in the mix design or mixing procedure shall be made immediately in a manner approved by the Engineer.

If an additional source of supply for materials is submitted and approved, the job mix formula shall be readjusted as necessary by the Contractor and submitted to the Engineer. All job mix formulas submitted and found unacceptable shall be readjusted to the satisfaction of the Engineer.

823.19 Job Mix Formula Types A, B, C, D, and E. The general composition limits prescribed in this Section are master ranges of tolerance to govern mixtures made from all raw materials conforming to the requirements of Sections 804 and 805. The composition limits are maximum and minimum in all cases. Closer control may be required for job materials used for specific projects according to the job mix formula. No work shall be started on the Contract, and no mixture will be accepted for the work, until the proposed job mix formula has been approved. The Contractor shall submit a written proposal indicating the single definite percentage for each sieve fraction of aggregate and for the asphalt that the Contractor chooses as the fixed percentage for each component in the mix. The proposal shall also indicate the temperature at which the Contractor shall furnish the mixture at the plant. The approval of the job mix formula shall bind the Contractor to furnish paving mixtures that not only meet the master ranges, but also meet the exact formula set for the Project, within the allowable tolerances.

823.20 Gradation for Job Mix Formula Types A, B, C, D, and E.

Sieve Size	Type A (%)	Type B (%)	Type C (%)	Type D & E (%)	Job Mix Tolerance (%)
22" (63 mm)	100	---	---	---	"7
2" (60 mm)	90 - 100	---	---	---	"7
12" (37.5 mm)	60 - 90	---	---	---	"7
13" (31.5 mm)	---	100	---	---	"7
1" (25.0 mm)	40 - 75	95 - 100	---	---	"7
3/4" (19.0 mm)	---	75 - 95	---	---	"7
1/2" (12.5 mm)	30 - 65	50 - 85	100	---	"7
3/8" (9.5 mm)	---	45 - 70	85 - 100	100	"7
#4 (4.75 mm)	20 - 45	30 - 50	50 - 75	80 - 100	"7
#8 (2.36 mm)	---	22 - 38	33 - 59	70 - 90	"4
#30 (600 Fm)	---	9 - 23	14 - 32	30 - 55	"4
#50 (300 Fm)	---	6 - 18	7 - 26	15 - 40	"4
#200 (75 Fm)	2 - 10	3 - 10	3 - 10	5 - 15	"2
A.C., %	2.0 - 4.0	3.5 - 5.5	4.5 - 6.5	6.0 - 8.5	"0.4
Temp. EF	225 - 275	275 - 325	275 - 325	275 - 325	"20EF
Temp. EC	(107 - 135)	(135 - 163)	(135 - 163)	(135 - 163)	"11

The percentages for aggregates are based on the total weight of aggregate. The percentages for asphalt cement are based on the total weight of the mix.

Washed gradations of final products shall be used to determine the amount of No. 200 (75 µm) material. The washed dust to effective asphalt ratio shall be between 0.6 and 1.2 for the final mixture.

823.21 Marshall Properties for Job Mix Formula Types A, B, C, D, and E.

Specification Requirements	*Mix Type*			
	A	*B*	*C*	*D & E*
Air Voids, % (Compacted Specimen)	---	3.0 - 5.0	3.0 - 5.0	3.0 - 5.0
Stability, (Minimum)	750 lb (3.4 kN)	1000 lb (5.3 kN)	1000 lb (5.3 kN)	1000 lb (5.3 kN)
Flow, 0.01 in (0.25 mm)	8.0 - 20.0	8.0 - 20.0	8.0 - 20.0	8.0 - 20.0
Voids in Mineral Aggregate (VMA)*, % (Minimum)	11.5	13.0	16.0	18.0

* The VMA shall be calculated from the combined bulk specific gravities of the aggregate and the actual asphalt cement content determined by the laboratory testing.

823.22 General Uses for Job Mix Formula Types A, B, C, D, and E.

Type A - Open plant mix base course
Type B - Dense graded base and binder course
Type C - Dense graded surface course
Type D - Fine, dense graded surface course
Type E - Curb mix

823.23 Bituminous Concrete Base Course Mixture. Mix and gradation requirements for the base course mixture shall be as follows:

1. Mix Requirements:

Asphalt Content	3.0 - 4.5% of total mixture weight
Air Voids	3.0 - 6.0
Stability	1000 lb. (4.5 kN), minimum
Flow-	8.0 - 18.0 (0.01 in) [0.25 mm]

2. Gradation Requirements:

Sieve Size	*Percent Passing*
12" (37.5 mm)	100
3/4" (19.0 mm)	75 - 100
3/8" (9.5 mm)	48 - 80
No. 8 (2.36 mm)	20 - 48
No. 30 (600 mm)	10 - 30
No. 50 (300 mm)	7 - 25
No. 200 (75 mm)	3 - 10

During production of the base course mixture, the gradation of the aggregates may vary between the specified limits, but such variations shall be gradual. Sudden variation from coarse to fine and fine to coarse on any sieve will not be tolerated.

823.24 Plant Mix Open-Graded Wearing Surface Mixture. The open-graded wearing surface shall be composed of a mixture of approved aggregate and asphalt cement. Gradation shall be as follows:

Sieve Size	***Master Range Percent Passing***	***Tolerance from Job Mix (")***
2" (12.5 mm)	100	0
3/8" (9.5 mm)	88-98	3
No. 4 (4.75 mm)	25 - 42	5
No. 8 (2.36 mm)	5-15	3
No. 200 (75 mm)	2-5	1.5

Asphalt cement shall be from 6.0 to 8.0% of the total mixture weight (to be determined by Laboratory Tests). The temperature of the asphalt cement shall not be greater than 310 " 10 ºF (154 " 6 ºC) when introduced into the mixer.

A heat-stable, anti-stripping additive conforming to the requirements of Subsection 823.05 shall be added to all asphalt cement used for open-graded surface course. The amount of the additive used shall be between 0.25 and 1.0% by weight of the asphalt cement as recommended by the additive manufacturer and approved by the Department's Materials and Research Section.

The additive shall be thoroughly and uniformly blended with the asphalt cement at the hot-mix production plant in accordance with Subsection 823.16.

The target temperature (" 10 EF) ["6 EC] of the mix leaving the mixer shall be established by the Department on the basis of laboratory tests. A target temperature of 240 " 10 EF (116 " 6 EC) is typical.

Aggregate shall conform to the requirements of Section 805, except slag will not be permitted. The use of limestone or serpentine aggregate or natural sand, washed or unwashed, is prohibited. The use of washed concrete sand is also prohibited.

823.25 Reclaimed Asphalt Pavement (RAP). This material consists of existing asphalt cement concrete pavement material removed by cold milling, or removed and processed such that 100% passes the 1" (25 mm) sieve. If the Contractor has a supply of RAP meeting the approval of the Engineer, a percentage of this material, meeting the requirements of Subsection 823.26 may be substituted for the new materials required to produce bituminous base, binder, or dense surface courses.

The stockpile of RAP shall be free of topsoil, debris, foreign matter, and other contaminants.

823.26 Recycled Asphalt Concrete Mixture. The recycled mixture shall be a blend of RAP, new aggregate, and asphalt cement conforming to the mixture requirements of this Section for the type mix specified. The new aggregate shall conform to the requirements of Subsections 823.03 and 823.04. The new asphalt shall conform to the requirements of Subsection 823.02. The percentage of new aggregate is not fixed by this Subsection; however, limitations are placed on the RAP percentage permitted in the recycled mix. A job mix formula must be submitted to the Engineer per Subsection 823.19 and approved prior to initiation of work and for any subsequent changes in the blend of the mixture. The approved ratio of RAP to new aggregate and the percentage of new asphalt cement to be incorporated into the recycled asphalt concrete mixture will be determined by laboratory tests performed on representative samples of stockpiled RAP and new aggregate.

The physical properties of the RAP asphalt cement will be determined by extraction, recovery, and testing. The testing of the physical properties will govern the percentage of RAP permitted in the recycled mix. In all mixture types, the contribution of the RAP asphalt cement shall not exceed 50% of the design asphalt content for the recycled mix.

In addition, the following plant limitations shall apply to all recycled mixtures:

Table 823-A

Maximum Percentage of RAP

Plant Type	*Mixtures*		
	Deep Lift	*Type B*	*Type C*
Dryer-Drum	20	10	10
Batch Plant	20	10	10

Results of single extractions and sieve tests shall not be used as the sole basis for acceptance or rejection of the mixture. Any variation from the job mix formula in the gradation of the aggregate or in the asphalt content that exceeds the tolerances noted below shall be investigated, and the conditions causing the variation shall be corrected.

The following tolerances for the job mix formula will be allowed per single test:

Sieve Size	***Percent Passing***
2" (12.5 mm) and larger	"8
No. 4 (4.75 mm) and 3/8" (9.5 mm)	"7
No. 100 (150 mm) to No. 8 (2.36 mm) (inclusive)	"5
No. 200 (75 mm)	"3
Asphalt content, weight percent of total mixture	"0.4

823.27 Recycled Mix Production. Recycled mixtures may be produced in batch or dryer-drum type plants.

Batch plants shall use the heat transfer method, by introducing the RAP into the plant weigh box at the ambient temperature of the stockpile. With this method, the uncoated, virgin aggregate, shall be superheated in the dryer and transfer its heat to the cold RAP in the plant mixer. A conveying system shall be used to introduce the proper amount of RAP per batch into the weigh box in sequence with the superheated aggregates from the plant hot bins. The mixing cycle shall include a minimum 15-second dry mix cycle prior to introduction of the hot asphalt cement. The mixture produced shall be of uniform, specified temperature, evenly coated, unsegregated, and shall have all the characteristics typical of a virgin aggregate-asphalt mixture for the type mix produced.

Dryer-drum plants used in the production of recycled mixtures shall be specifically designed and equipped by the manufacturer to provide for entrance of the RAP material into the drum with subsequent heating, and for mixing the RAP with the new aggregate and asphalt without direct flame contact, excessive asphalt hardening, or violation of air quality standards. The mixture produced shall be uniform, at the specified temperature, evenly coated, unsegregated, and have all the characteristics typical of a virgin aggregate-asphalt mixture for the type mix produced.

823.28 Use of Recycled Mixtures. Unless prohibited by the Contract, the use of recycled mixtures for the mix types specified by the Contract shall be at the option of the Contractor. All provisions of Sections 401 and 823, except as modified in Subsections 823.25, 823.26, and 823.27, shall govern materials, production, storage, transportation, spreading, finishing, and compaction of recycled materials for the appropriate mix type provided.

SECTION 824 EMBEDDED REINFORCEMENT AND HARDWARE

824.01 Description. This material consists of bar reinforcement, wire mesh reinforcement, tie bars, dowel bars, hook bolts, W-bolts, and load transfer assemblies.

824.02 Material Requirements.

a. *Bar Reinforcement.* Bar reinforcement shall conform to the requirements of AASHTO M 31/M 31M, Grade 40 or Grade 60, (Grade 300 or Grade 400), as specified on the Plans.

b. *Epoxy Coated Bar Reinforcement.* Epoxy coated bar reinforcement shall conform to the requirements of AASHTO M 284/M 284M

c. *Wire Mesh Reinforcement.* Wire mesh reinforcement shall conform to the requirements of AASHTO M 55.

d. *Tie Bars.* Tie bars shall conform to the requirements of AASHTO M 31M.

e. *Hook Bolts.* Hook bolts used in lieu of deformed tie bars shall conform to the Plans and the Standard Construction Details.

f. *W-Bolts.* W-bolts shall conform to the Plans and the Standard Construction Details

g. *Coated Dowel Bars.* Coated dowel bars shall be round, steel bars of the diameter and length shown on the Plans, with a corrosion-resistant coating over a plain steel bar core, conforming to AASHTO M 255/M 255M, Grade 65 (Grade 450). The coating shall conform to AASHTO M 254 and be either Type A0, 25 " 5 mils (635 " 130 mm), multi-layer, low-bond plastic coating, or Type B, 7 " 2 mils (180 " 50 mm), fusion-bonded epoxy coating, requiring graphite application.

h. *Load Transfer Assemblies.* The load transfer device shall be fabricated from corrosion-resistant, coated dowel bars conforming to AASHTO M 254, Type A or Type B coating described in (g) above.

i. *Splice Couplers.* Splice couplers shall conform to the requirements specified on the Plans and shall be submitted to the Engineer for approval.

j. *Fiber Reinforcement*. Alkali resistant fiber reinforcement shall conform to the requirements of ASTM C 1116, Type III with a minimum fiber length of 2" (12 mm) and a maximum length of 12" (38 mm).

SECTION 825 FENCE

825.01 Description. This material consists of right-of-way fence and chain-link fence.

825.02 Right-Of-Way Fence. Right-of-way fence material shall conform to the following requirements:

a. *Metal Posts.* Tubular steel posts and braces shall conform to the requirements of AASHTO M 281 and shall be galvanized in accordance with AASHTO M 111.

   Steel posts of tee, channel, wide flange, or U-bar shapes, shall be formed structural steel, hot-rolled carbon steel, or hot-rolled rail steel, having a minimum yield strength of 40,000 psi (280 MPa) and a minimum ultimate strength of 70,000 psi (480 MPa). Steel posts shall be either galvanized in accordance with AASHTO M 111, painted with weather resistant paint that is specifically designed for steel, or painted with enamel that has been shop or factory baked.

b. *Barbed Wire.* Barbed wire shall be galvanized steel conforming to the requirements of AASHTO M 280 and shall consist of two-strand 122 gage (2.51 mm) wire with tightly wrapped, sharp, four-point barbs formed of 14 gage (2.03 mm) wire spaced evenly at not more than 5" (130 mm) intervals. Galvanizing shall be Class 3.

c. *Woven Wire Fencing.* Woven wire fencing or woven wire fabric shall be 9 gage (3.77 mm) galvanized wire conforming to the requirements of AASHTO M 279, Class 3 coating or 9 gage (3.77 mm) aluminum coated steel wire conforming to the requirements of ASTM A 584 with a minimum coating weight of 0.4 oz/ft5 (120 g/m5).

825.03 Chain-Link Fence. Chain-link fence shall be either galvanized steel fabric fence, aluminum-coated steel fabric fence, or aluminum alloy fabric fence, conforming to the appropriate requirements of AASHTO M 181.

SECTION 826 STRUCTURAL STEEL

826.01 Description. This material consists of structural steel, fasteners, bearings, and related materials fabricated, painted, and inspected in a shop environment. Related field activities such as erection and field painting are specified in Section 605. Requirements for working drawings are specified in Subsection 105.04.

MATERIAL REQUIREMENTS.

826.02 Structural Steel. Materials shall be stored in accordance with Subsection 605.03.

Structural steel for bolted and welded steel structures shall be furnished according to the following specifications unless otherwise specified:

a. Structural carbon steel for bolted or welded construction conforming to AASHTO M 183/M 183M shall be furnished.

b. Steel for eyebars shall be of weldable grade. These grades include:

   1. Structural steel conforming to AASHTO M 183/M 183M,

   2. Structural steel conforming to AASHTO M 222/M 222M,

   3. High-strength low-alloy structural manganese vanadium steel conforming to AASHTO M 223/M 223M, and

   4. High-strength low-alloy structural steel conforming to AASHTO M 270/M 270M.

c. High-strength low-alloy structural steel shall conform to:

   1. AASHTO M 222/M 222M, or

   2. AASHTO M 223/M 223M, or

   3. AASHTO M 244/M 244M.

d. High-strength low-alloy structural steel for welding shall conform to:

1. AASHTO M 223/M 223M, Grades 42 and 50 (Grades 290 and 345). Structural shapes shall be limited to Groups 1, 2, and 3 of AASHTO M 160/M 160M. Plates and bars of Grade 42 (Grade 290) shall be limited to thicknesses through 4" (100 mm). Plates and bars of Grade 50 (Grade 345) shall be limited to thicknesses through 12" (38 mm).

2. AASHTO M 222/M 222M. The following supplemental requirements for impact properties shall be met:

    a. *Impact Tests.* The Contractor shall provide the heat qualification results for one impact test from the thickest material and one impact test for the thinnest material for each heat and product furnished. The impact test shall be the longitudinal Charpy V-Notch (CVN) test conforming to the requirements of AASHTO T 244. Products are defined as plates, shapes, and bars. If less than 50 tons (45 metric tons) of a product are supplied using a given heat, only one impact test for the thickest material is required for that heat.For a heat to qualify, the average energy absorbed at 40 ºF (4 ºC) on the test specimens shall not be less than 15 foot pounds (20 J), except when sub-size specimens are required. The minimum average energy absorption for sub-size test specimens shall be as follows:

Size	***Energy Absorption***
10 by 7.5 mm	12 ft lb (16 J)
10 by 5 mm	8 ft lb (11 J)

One impact test consists of the average value of three adjacent specimens. The results for a single specimen may be below the above specified minimum values, but in no case below two-thirds of the value. If more than one value is below the specified minimum, or if one specimen is below two-thirds of the specified minimum, a retest of three additional specimens shall be made. Each retest must equal or exceed the specified minimum. If the thickest or thinnest material tested fails to qualify, the thickness or those thicknesses shall be rejected. However, the next thinner or thicker material to be furnished may be tested. If the retest results meet the requirements, the heat will be considered qualified for those thicknesses represented by the retest.

The governing thickness for beams, tees, and channels shall be the average flange thickness. The governing thickness for angles shall be the specified leg thickness. Test specimens for these sections shall be taken at a point one-third the distance from the outer edge of the flange or leg to the web or heel of the section.

Requirements for Notch Toughness. Requirements are provided herein for notch toughness of the steel. These are mandatory for material designated as main load carrying member components subject to tensile stress.

The material supplied shall meet the longitudinal CVN tests specified in Table 826-A.

Sampling and testing procedures shall be in accordance with AASHTO T 243/T 243M.

Table 826-ACharpy V-Notch Test Requirements

Steel Designation	*Thickness*	*Equivalent Absorbed Energy*	*Frequency of Testing*
AASHTO M 183/M 183M	Up to 4" (100 mm)	15 ft lb @40 ºF (20 J @ 4 ºC)	H**
AASHTO M 222/M 222M	Up to 2" (50 mm), welded	15 ft lb @ 40 ºF (20 J @ 4 ºC)	H
	over 2 to 4" (51 to 100 mm), welded	20 ft lb @ 40 ºF (27 J @ 4 ºC)	
	Up to 4" (100 mm), mechanically fastened	15 ft lb @ 40 ºF (20 J @ 4ºC)	
AASHTO M 223/M 223M*	Up to 2" (50 mm), welded	15 ft lb @ 40 ºF (20 J @ 4 ºC)	H
	Up to 4" (100 mm), mechanically fastened	15 ft lb @ 40 ºF (20 J @ 4 ºC)	
AASHTO M 244/M 244M	Up to 22" (64 mm), welded	25 ft lb @ 0 ºF (34 J @ -18 ºC)	P***
	22 to 4" (65 to 100 mm), welded	35 ft lb @ 0 ºF (47 J @ -18 ºC)	
	Up to 4" (100 mm), mechanically fastened	25 ft lb @ 0 ºF (34 J @ -18 ºC)	

* If the yield point of the material exceeds 65 ksi (450 MPa), the temperature for the CVN value for acceptability shall be reduced by 15 ºF (8 ºC) for each increment of 10 ksi (70 MPa) above 65 ksi (450 MPa).

** "H" (Heat Testing)

*** "P" (Piece Testing)

The materials subject to the notch toughness requirements are the main load carrying components under tensile stress. The main load carrying member components are the flanges, webs, and splice plates of the steel girders.

e. High-strength structural steel for bolted construction shall conform to:

1. AASHTO M 222/M 222M, or

2. AASHTO M 223/M 223M, or

3. AASHTO M 244/M 244M.

826.03 Fasteners. The Contractor shall provide a supplier's certification for all bolts, nuts, and washers. This certification shall include origin of all materials, result of the rotational-capacity tests, date and location of tests, and zinc thickness on galvanized fasteners. Lot numbers of fasteners shall be listed on the certificate and the shipping papers.

Bolts, nuts, and circular washers shall conform to the requirements of AASHTO M 164 (M 164M), Type 1 including suitable nuts and plain hardened washers. Bolts manufactured to AASHTO M 164M are marked on the top of the head with three radial lines and the symbol **A325 (A 325M)**. Nuts are marked on one face with three similar circumferential markings, 120 degrees apart, or alternatively, with **C**, **2**, **D**, **2H**, or **DH**. Bolt and nut dimensions shall conform to Table 826-B for heavy hexagon structural bolts and for heavy semi-finished nuts, except as allowed in the following paragraph.

Bolts	***Nuts***
A 325 (A 325M) A 490 (A 490M)	ASTM A 563 (A 563M)

When specified on the Plans, or at the option of the Contractor, bolts, nuts, and circular washers conforming to the requirements of AASHTO M 253 (M 253M), Type 1, quenched and tempered shall be used. Alloy steel bolts for structural steel joints shall be furnished.

Subject to the approval of the Engineer, other fasteners which meet the chemical composition requirements of AASHTO M 164 (M 164M) and which meet the mechanical requirements of the same specifications in full-size tests, and which have body diameter and bearing areas under the head and nut, or their equivalent, not less than those provided by a bolt and nut of these same nominal dimensions referenced in Table 826-B, may be used. Such alternate fasteners may differ in other dimensions from those specified for AASHTO M 164 (M 164M) bolts and nuts.

Table 826-B Bolt and Nut Dimensions - US Customary Unit

Nominal Bolt Size (D)	*Bolt Dimensions, in Inches Heavy Hexagon Structural Bolts*			*Nut Dimensions, In Inches Heavy-Semi-Finished Hexagon Nuts*	
	Width Across Flats (F)	*Height (H)*	*Thread Length (T)*	*Width Across Flats (W)*	*Height (H)*
1/2	7/8	5/16	1	7/8	31/64
5/8	1-1/16	25/64	1-1/4	1-1/16	39/64
3/4	1-1/4	15/32	1-3/8	1-1/4	47/64
7/8	1-7/16	35/64	1-1/2	1-7/16	55/64
1	1-5/8	39/64	1-3/4	1-5/8	63/64
1-1/8	1-13/16	11/16	2	1-13/16	1-7/64
1-1/4	2	25/32	2	2	1-7/32
1-3/8	2-3/16	27/32	2-1/4	2-3/16	1-11/32
1-1/2	2-3/8	15/16	2-1/4	2-3/8	1-15/32

Table 826-B

Bolt and Nut Dimensions - Metric Units

NominalBolt Size(D)	*Heavy Hexagon Structural Bolt Dimensions (mm)*			*Nut Dimensions (mm)*	
	Width Across Flats (F)	*Height (H)*	*Thread Length (T)*	*Width Across Flats (W)*	*Height (H)*
13	22	8	25	22	12
16	27	10	32	27	15
19	32	12	35	32	19
22	36	14	38	36	22
25	41	15	44	41	25
28	46	17	50	46	28
32	50	20	50	50	31
35	55	21	57	55	34
38	60	24	57	60	37

Circular washers shall be flat and smooth and their nominal dimensions shall conform to dimensions referenced in Table 826-C.

Beveled washers for American Standard Beams and Channels shall be square or rectangular, shall taper in thickness, and shall conform to the dimensions given in Table 826-C.

Where necessary, washers may be clipped on one side to a point not closer than seven-eighths of the bolt diameter from the center of the washer.

Table 826-C Washer Dimensions [a] - US Customary Units

Circular Washers					*Square or Rectangular BeveledWashers for AmericanStandard Beams and Channels*		
Bolt Size (D)	*Nominal Outside Diameter [b]*	*Nominal Diameter of Hole*	*Thickness*		*Minimum Side Dimension*	*Mean Thickness*	*Slope of Taper in Thickness*
			Minimum	***Maximum***			
1/2	1-1/16	17/32	.097	.177	1-3/4	5/16	1:6
5/8	1-5/16	21/32	.122	.177	1-3/4	5/16	1:6
3/4	1-15/32	13/16	.122	.177	1-3/4	5/16	1:6
7/8	1-3/4	15/16	.136	.177	1-3/4	5/16	1:6
1	2	1-1/16	.136	.177	1-3/4	5/16	1:6
1-1/8	2-1/4	1-1/4	.136	.177	2-1/4	5/16	1:6
1-1/4	2-1/2	1-3/8	.136	.177	2-1/4	5/16	1:6
1-3/8	2-3/4	1-1/2	.136	.177	2-1/4	5/16	1:6
1-1/2	3	1-5/8	.136	.177	2-1/4	5/16	1:6
1-3/4	3-3/8	1-7/8	.178[c]	.28[c]	---	---	---
2	3-3/4	2-1/8	.178	.28	---	---	---
Over 2 to 4 inc.	2D-1/2	D+1/8	.24 [d]	.34 [d]	---	---	---

[a] Dimensions in inches

[b] May be exceeded by 1/4 in.

[c] 3/16 in. nominal

[d] 1/4 in. nominal

Table 826-C Washer Dimensions [a] - Metric Units

Circular Washers					*Square or Rectangular Beveled Washers for American Standard Beams*		
Nominal Bolt Size (D)	*Nominal Outside Diameter [b]*	*Nominal Diameter of Hole*	*Thickness*		*Minimum Side Dimension*	*Mean Thickness*	*Slope of Tape*
			Minimum	***Maximum***			
13	27	13	3	5	44	8	1:6
16	33	17	3	5	44	8	1:6
19	37	21	3	5	44	8	1:6
22	44	24	4	5	44	8	1:6
25	50	27	4	5	44	8	1:6
28	57	32	4	5	57	8	1:6
32	63	35	4	5	57	8	1:6
35	69	38	4	5	57	8	1:6
38	75	41	4	5	57	8	1:6
44	85	47	5 [c]	7 [c]	---	---	---
50	94	53	5	7	---	---	---
51 to 100	2D-13	D-3	6 [d]	9 [d]	---	---	---

[a] millimeters [c] 5 mm nominal

[b] May be exceeded by 6 mm [d] 6 mm nominal

Unless otherwise specified on the Plans, all high-strength bolts, nuts, and washers shall be mechanically galvanized in accordance with AASHTO M 298. Coating thickness, adherence, and quality requirements, however, shall conform to Class C of AASHTO M 232. Type 3, AASHTO M 164 (M 164M) and AASHTO M 253 (M 253M), bolts, nuts, and washers specified for use with unpainted, AASHTO M 270/M 270M, GRADE 345W connections shall not be galvanized. Ungalvanized AASHTO M 253 (M 253M) bolts and hardware will not be used for hot-dipped galvanized connections. In addition, hot-dip galvanizing of Type 3, AASHTO M 164 (M 164M) or AASHTO M 253 (M 253M), bolts will not be permitted.

826.04 Shear Connectors. Shear connector studs shall conform to the requirements of AASHTO M 169 for cold-finish carbon steel bars and shafting, and cold-drawn bars, Grades 1015, 1018, or 1020, either semi-kilned or fully-kilned. If flux-retaining caps are used, the steel for the caps shall be of a low-carbon grade suitable for welding and shall comply with ASTM A 109 (A 109M) for cold-rolled, carbon-steel strip.

Tensile properties as determined by tests of bar stock after drawing or of finished studs shall conform to the following requirements:

Tensile strength (minimum)	60 ksi (415 MPa)
Yield strength * (minimum)	50 ksi (345 MPa)
Elongation (minimum)	2'' (50 mm)
Reduction in area (minimum)	50%

* As determined by a 0.2% offset method

Tensile properties shall be determined according to the applicable sections of AASHTO T 244 for mechanical testing of steel products. Tensile tests of finished studs shall be made on studs similar to those shown in Table 826-D.

If fracture occurs outside the middle half of the gage lengths, the test shall be repeated.

Finished studs shall be of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends, or other injurious defects. Finishing shall be as produced by cold-drawing, cold-rolling, or machining.

The studs shall conform to the dimensions given in the following table:

Table 826-D Shear Connector Studs standard dimensions and tolerances in inches (millimeters)

Shank			*Head*	
Diameter (c)		*Length* (L)*	*Diameter (H)*	*Thickness (T)*
3/4	(19)	4+0.062 (100+1.6)	13 + 1/64	3/8 minimum
+0.000 (+0.00)		-0.125 (-3.2)	(32 +0.5)	(9.5 minimum)
0	(0)			
-0.015	(-0.5)			
7/8	(22)	4+0.062 (100 +1.6)	1 3/4 + 1/64	3/8 minimum
+0.000 (+0.00)		-0.125 (-3.2)	(44 +0.5)	(9.5 minimum)
0	(0)			
-0.015	(-0.5)			

* Length includes thickness of head. Standard length is 4'' (100 mm) but other lengths may be obtained by special order.

The Contractor shall furnish the manufacturer's certification that the studs as delivered are in accordance with the material requirements of this Section. Certified copies of in-plant quality control test reports shall be furnished to the Engineer upon request.

It shall be the Contractor's responsibility to comply with all requests of the inspector to correct improper workmanship and to remove and replace, or correct as instructed, all welds found defective or deficient. The Department will inspect all welds using visual inspection or nondestructive testing.

826.05 Castings.

a. *Carbon Steel Forgings.* Steel forgings shall conform to AASHTO M 102, Class C, unless otherwise specified.
b. *Cold Finished Carbon Steel Shafting.* Cold finished carbon steel shafting shall conform to AASHTO M 169, Grade Designation 1016-1030, inclusive, unless otherwise specified.
c. *Alloy Steel Forgings.* Alloy steel forgings shall conform to AASHTO M 102, Class G, unless otherwise specified.
d. *Steel Castings for Highway Bridges.* Steel castings for use in highway bridge components shall conform to AASHTO M 192/M 192M, Class 70 (Class 485), Grade 70-36 (Grade 485-250) steel, or AASHTO M 103/M 103M.
e. *Chromium Alloy-Steel Castings.* Chromium alloy-steel castings shall conform to AASHTO M 163/M 163M, Grade CA-15, unless otherwise specified.
f. *Iron Casting.* Iron casting shall be gray-iron castings conforming to AASHTO M 105, Class No. 30, unless otherwise specified.
g. *Ductile Iron Castings.* Ductile iron castings shall conform to ASTM A 536, Grade 60-40-18, unless otherwise specified.
h. *Malleable Castings.* Malleable castings shall conform to ASTM A 47M, Grade No. 22010, unless otherwise specified.
i. *Workmanship, Finish, and Cleaning for Iron Castings, Ductile Iron Castings, and Malleable Castings.* Castings shall be true to pattern in form and dimensions, and free from pouring faults, sponginess, cracks, blow holes, or other defects in positions affecting their strength and value for the service intended.

   The castings shall be boldly filleted at angles. The arrises shall be sharp and perfect.

All castings must be sandblasted or otherwise effectively cleaned of scale and sand to present a smooth, clean, and uniform surface.

j. *Bronze Castings.* Bronze castings shall conform to AASHTO M 107, Alloy UNS No. C91300 or C90500 modified with up to 2.5% lead maximum.

826.06 Bearing Materials.

a. *Elastomeric Bearing Pads.* The elastomeric bearing pads shall be cast in a single, integral layer. Multiple-layer pads, separated by non-elastic sheets to resist deformations in thick pads, may be permitted. The variation in thickness in the longitudinal direction (taper) shall not exceed 5% of the length of the pads. The least horizontal dimension of the pads shall not be less than five times the thickness (shape factor l.25 minimum).

b. *Copper-Alloy Plates.* Copper-alloy plates shall conform to AASHTO M 108, Copper Alloy UNS No. C51000 or C65500.

c. *Polytetraflourethylene - Stainless Steel Structural Bearings.* The polytetrafluorethylene (TFE) self-lubricating bearing element shall be composed of 100% virgin (unfilled) TFE polymer, bonded to a rigid confining substrate. The substrate shall limit the flow (elongation) of the confined TFE to not more than 0.009'' (225 μm) under a load of 2000 lb (14 MPa) for 15 minutes at 78 EF (26 EC) for a 2 by 3'' (50 by 75 mm) test sample. The virgin (unfilled) TFE shall have a thickness of not less than 1/32'' (1 mm). The properties of the TFE shall conform to the requirements of following table:

Table 826-E TFE Properties

Requirements	*Test Method*	*Value*
Hardness at 78 EF (26 EC)	ASTM D 2240	50-65 Durometer D
Tensile Strength, psi (MPa)	ASTM D 1457	2800 (20) (min. avg.)
Elongation, %	ASTM D 1457	200 (min. avg.)
Deformation under load, % at 78E F (26 EC), 2000 psi (14 MPa)	ASTM D 621	4 (max.)
1/2 x 1/2 x 1/32" (13 by 13 by 1 mm)		
Specific Gravity	ASTM D 792	2.14 to 2.21

The preformed fabric bearing pad shall consist of multiple layers of 8 oz (227 g) duck impregnated with high quality rubber, capable of withstanding loads of 10 ksi (70 MPa) perpendicular to the plane of lamination without detrimental reduction in thickness and without extrusion. Actual dimensions are determined by the design criteria noted on the structural drawings. The bearing pad shall meet the environmental requirements of MIL-STD-810E(2).

The stainless steel shall be no less than 16 gage (1.5 mm) meeting the AISI Type 304 (ASTM A 240) requirements and have a mirror finish of less than 10 microinches Root-Mean-Square (0.25 μm) on the side in contact with the TFE. The stainless steel shall be 1/8'' (3 mm) smaller than the sole plate all around. The stainless steel shall be mechanically bonded to the sole plate.

The coefficient of friction between the self lubricating bearing element (TFE) and the stainless steel shall not be more than 0.06 at 800 psi (5.6 MPa) compressive loading.

The sole plate and base plate shall be the same type of structural steel specified for the steel structure. The dimensions shall comply with the details as shown on the structural drawings. All exposed surfaces shall be given the coating specified for the steel structure. Unless otherwise specified, a base plate shall be used for each bearing.

The bearing pad shall have a shore "A" hardness of 90 '' 5. The expansion bearing total thickness will be ''10%. The TFE thickness shall be -0, + 0.015'' (-0, +0.4 mm).

d. *Steel - Bronze Bearings and Rocker Bearings.* The steel used for bearings shall be the same type of steel designated for the steel structure unless otherwise specified. All exposed surfaces, except sliding surfaces, shall receive the same coating used for the structural steel.

Steel surfaces of the sole plate, rocker plate, and web and bearing plates in contact with other surfaces, shall be machine finished to at least 250 microinches Root-Mean-Square (6.4 μm). Surfaces of the sole plate and masonry plate in contact with the bronze plate shall have a machine finish of at least 125 microinches Root-Mean-Square (3.2 μm). The sliding surfaces shall be coated with a multipurpose grease before shipment. Prior to erection, the coating shall be removed using a solvent.

The bearing shall be shop assembled and match-marked to ensure proper fit.

Bevel the sole plate to match the grade if the grade exceeds 1%. For low profile fixed bearings, bevel the sole plate if grade exceeds 3%.

Self-lubricating bronze bearing plates shall conform to the requirements of AASHTO M 107, Alloy C91100 unless otherwise specified. The sliding surfaces of the plates shall be polished and provided with annular grooves or cylindrical recesses, or a combination thereof, filled with a lubricating compound. The compound shall be free of any material that could cause abrasive or corrosive action upon the metal surfaces and also shall be able to withstand extremely high pressures and the atmospheric elements over long periods of time. The lubricating compound shall be compressed into the recesses under sufficient pressure to form a non-plastic, lubricating inset. The lubricating inset shall comprise not less than 25% of the total area of the plate. The frictional coefficient shall not exceed 0.10 during the first 1000 cycles at the design dead load.

e. *Elastomeric Bearings.* Elastomeric bearings shall conform to the AASHTO Standard Specifications for Highway Bridges, Section 18, Division II. The elastomer having a durometer hardness of 70 shall not be used in laminated bearings.

To prevent any relative movement between the bearing pad and the sole plate or the masonry, the Contractor shall perform one of the following:

1. Use epoxy and grit on the bottom surface of the sole plate and roughen the bridge seat, or

2. Use bonding compound approved by the Engineer to bond the contact surfaces. The beam and bearing pad shall be set in place before the bonding compound hardens.

The relative motion may be prevented using other methods recommended by the Contractor or the manufacturer, subject to the Engineer's approval.

826.07 Galvanizing. When galvanizing is shown on the Plans or specified in the Special Provisions, most ferrous metal products shall be galvanized in accordance with AASHTO M 111. High-strength bolts and other small, highly-stressed parts shall be mechanically galvanized as specified in Subsection 826.03.

826.08 Sheet Zinc. Sheet zinc shall conform to ASTM B 69, Type II.

SHOP FABRICATION.

826.09 Quality of Workmanship. Fabrication of primary load carrying members will require AISC Category I or III shop certification.

826.10 Connections Using High Strength Bolts. Connections using high-strength bolts shall conform to the requirements of Subsection 605.15.

826.11 Plate Cut Edges. Plate cut edges shall conform to the requirements of Subsection 605.16.

826.12 Welding and Oxygen Cutting. Temporary or permanent welds not shown on the Plans or permitted by this Section or Subsection 605.17 shall not be made without specific written authorization by the Engineer.

All welding and oxygen cutting shall conform to AWS D1.1 and ANSI/AASHTO/AWS D1.5.

Welding of steel structures and nondestructive testing of welds shall conform to ANSI/AASHTO/AWS D1.5. All nondestructive testing required shall be done by the Contractor in the presence of the Department's inspector.

1. *Welding Processes.* Manual shielded metal arc and submerged arc welding procedures covered in ANSI/AASHTO/AWS D1.5 are approved for use without procedure qualification tests.

   Vertical submerged arc, electrogas arc, and electroslag welding processes shall not be used unless called for in the Plans or Special Provisions. The Contractor may request permission to use these processes from the Engineer by written notification. The Engineer will make the final decision as to the suitability of such processes.

   The Engineer will not authorize the use of gas shielded, metal arc welding processes for welding of primary stress members (main girders, transverse beams, sign bridges, bridge bearings, etc.) or for any welded connections on either primary or secondary stress members. Consideration and authorization to use other welding processes may be given for welding of secondary stress members such as diagonal bracing to gusset plates, gusset plates to stiffeners, bridge railing posts, railing splices, grates, grate frames, and drain pipes.

   Processes outlined in ANSI/AASHTO/AWS D1.5 and authorized for use in fabrication shall conform to the applicable provisions of the Contract.
2. *Inspection of Welding.* The Contractor shall notify the Engineer at least 30 calendar days in advance of the beginning of work at the steel fabrication shop. The Engineer or the Engineer's authorized representative will be under no obligation to accept any shop work performed before the 30th day after such notice.

   Nondestructive inspection includes radiographic, magnetic particle, dye penetrant, and ultrasonic methods, as well as any other type of inspection the Contractor proposes to use with the Engineer's approval.

   Edges of flange butt welds in tension areas shall be magnetic particle (yoke method) or dye penetrant tested.

   Ultrasonic testing may be used, when approved, in lieu of radiographic testing and shall be in accordance with AWS/AASHTO specifications.

   Nondestructive testing in addition to visual inspection shall be performed by the Contractor and shall be in compliance with the requirements of AWS D1.1 and as modified by ANSI/AASHTO/AWS D1.5.

   All inspections shall be performed by a firm or agent employing qualified welding inspection personnel and using equipment approved by the Department. The Contractor shall inform the Department's inspector (or the Department's inspection agency) of the name of its inspecting firm and the identity of the equipment to be used. No fabricated steel shall be inspected or accepted until the firm and its equipment have been approved.

   All radiographing, magnetic particle, ultrasonic and other nondestructive testing inspection shall be performed in the presence of the Department's representative. All radiographing, magnetic particle, ultrasonic, and other nondestructive testing inspection performed without the Department's representative present will not be accepted and shall be repeated with the Department's representative present. The Contractor's inspector and the Department's representative shall jointly ascertain that each radiograph is photographically marked with a suitable identification indicating exactly where the image was taken on the beam or girder.
3. *Prequalification of Welding Operators.* All fabrication shop welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1, as modified by ANSI/AASHTO/AWS D1.5. The Contractor shall ensure that the fabricator retains certified copies of the qualification test records (AWS D1.1, Appendix E) and requalification tests, if appropriate, for use by the Department's authorized representative upon demand. In addition, records shall be maintained by the Contractor to ensure compliance with AASHTO and AWS requirements for the period of effectiveness as indicated in AWS D1.1, Section 5.30.

826.13 Assembly.

a. *Shop Assembly.* The field connections of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames shall be assembled in the shop with milled ends of compression members in full bearing. While the connections are assembled the subsize holes shall be reamed to the specified size. Assembly shall be *Full Truss or Girder Assembly* unless *Progressive Truss or Girder Assembly*, *Full Chord Assembly*, *Progressive Chord Assembly*, or *Special Complete Structure Assembly* is specified in the Special

Provisions or on the Plans.

A camber diagram shall be furnished to the Engineer by the Contractor showing the camber at each panel point of each truss, arch rib, continuous beam line, plate girder, or rigid frame. When the shop assembly is *Full Truss or Girder Assembly* or *Special Complete Structure Assembly*, the camber diagram shall show the camber measured during assembly. With any of the other methods of shop assembly, the camber diagram shall show the calculated camber.

Each assembly, including camber, alignment, accuracy of holes, and fit of milled joints, shall be approved by the Engineer before reaming is commenced.

b. *Full Truss or Girder Assembly.* This shall consist of assembling all members of each truss, arch rib, bent, tower face, continuous beam line, plate girder, or rigid frame at one time.

c. *Progressive Truss or Girder Assembly.* This shall consist of initially assembling for each truss, arch rib bent, tower face, continuous beam line, plate girder, or rigid frame at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths (i.e., length between field splices) and not less than 150' (45 m) in the case of structures longer than 150' (45 m). At least one shop section or panel or as many panels as are associated with a chord length shall be added at the advancing end of the assembly before any member is removed from the rearward end so that the assembled portion of the structure is never less than that specified above.

d. *Full Chord Assembly.* This shall consist of assembling, with geometric angles at the joints, the full length of each chord of each truss or open spandrel arch, or each leg of each bent or tower and then the reaming the field connection holes while the members are assembled and reaming the web member connections to steel templates set at the geometric (not cambered) angular relation to the chord lines.

   Field connection holes in web members shall be reamed using steel templates. At least one end of each web member shall be milled or shall be scribed normal to the longitudinal axis of the member. The templates at both ends of the member shall be accurately located from one of the milled ends or scribed lines.

e. *Progressive Chord Assembly.* This shall consist of assembling contiguous chord members in the manner specified for *Full Chord Assembly* and in the number and length specified for *Progressive Truss or Girder Assembly*.

f. *Special Complete Structure Assembly.* This shall consist of assembling the entire structure including the floor system. This assembly is ordinarily needed only for complicated structures such as those having curved girders or extreme skews in combination with severe grades or cambers.

826.14 Match-Marking. Connecting members assembled in the shop for the purpose of reaming holes in field connections shall be match-marked. A diagram showing such marks shall be furnished to the Engineer.

826.15 Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall conform to the surface roughness requirements as defined in ANSI/ASME B46.1, Part 1, as follows:

Steel slabs	2000 microinches (50 Fm)
Heavy plates in contact in shoes to be welded	1000 microinches (25 Fm)
Milled ends of compression members, stiffeners, and fillers	500 microinches (12.5 Fm)
Bridge rollers and rockers	250 microinches (6.3 Fm)
Pins and pin holes	125 microinches (3.2 Fm)
Sliding bearings	125 microinches (3.2 Fm)

826.16 Fabrication of Members. Unless otherwise shown on the Plans, steel plates for main members and splice plates for flanges and main tension members shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile compressive stress.

826.17 Annealing and Stress Relieving. Structural members which are indicated in the Contract to be annealed or normalized shall have finish machining, boring, and straightening done subsequent to heat treatment. Normalizing and annealing (full annealing) shall be as specified in ASTM E 44. The temperatures during the heating and cooling process shall be maintained uniformly throughout the furnace so that the temperature at any two points on the member will not differ by more than 100 EF (56 EC) at any one time.

A record of each furnace charge identifying the pieces in the charge and showing the temperatures and schedule actually used shall be provided. Proper instruments, including recording pyrometers, shall be provided for determining the temperatures of members in the furnace at all times. The records of the treatment operation shall be available to and meet the approval of the Engineer.

Members such as bridge shoes, pedestals, or other parts that are built up by welding sections of plate together shall be stress relieved, when required by the Plans, this Section, or Special Provisions governing the Contract, in accordance with procedures established by ANSI/AASHTO/AWS D1.5.

826.18 Pins and Rollers. Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws.

Pins and rollers more than 9'' (230 mm) in diameter shall be forged and annealed.

Pins and rollers 9'' (230 mm) or less in diameter may be either forged and annealed, or fabricated from cold-finished, carbon-steel shafting.

In pins larger than 9'' (230 mm) in diameter, a hole not less than 2'' (50 mm) in diameter shall be forged full length along the axis after the forging has been allowed to cool to a temperature below the critical range under suitable conditions, to prevent injury by too rapid cooling, and before being annealed.

826.19 Boring Pin Holes. Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles to the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside to outside of end holes in tension members and inside to inside of end holes in compression members shall not vary from that specified more than 1/32'' (1 mm).

826.20 Pin Clearances. The diameter of the pin hole shall not exceed that of the pin by more than 1/50'' (0.5 mm) for pins 5'' (125 mm) or less in diameter, or 1/32'' (1 mm) for larger pins.

826.21 Threads for Bolts and Pins. Thread for all bolts and pins for structural steel construction shall conform to the Unified Standard Series UNC-ANSI B1.1, Class 2 A for external threads and Class 2 B for internal threads, except that pin ends having a diameter of 1 3/8'' or more shall be threaded 6 threads to the inch. (Threads for all bolts for structural steel construction shall conform to ANSI/ASME B1.13M, Class 6H. Class 6G threads for pin ends having a diameter of 35 mm or more shall be threaded.)

826.22 Pilot and Driving Nuts. Two pilot nuts and two driving nuts for each size of pin shall be furnished, unless otherwise specified.

826.23 Notice of Beginning of Work. The Contractor shall give the Engineer 30 days notice prior to the beginning of work at the mill or in the shop so that inspection may be provided. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before the Engineer has been so notified.

826.24 Facilities for Inspection. The Contractor shall furnish equipment, material, and work space for the inspection of material and workmanship in the mill and shop. The inspectors shall be allowed free access to the necessary areas of the mill and shop.

826.25 Identification of Steels During Fabrication. The Engineer shall be furnished with complete certified mill test reports showing chemical analysis and physical tests for each heat of steel for all members, unless excepted by the Engineer. Each piece of steel to be fabricated shall be properly identified for the Engineer.

Shop drawings shall specifically identify each piece that is made of steel. Pieces made of different grades of steel shall not be given the same assembling or erecting mark even though they are of identical dimensions and detail.

The Contractor's system of assembly marking individual pieces made of steel other than AASHTO M 183/M 183M steel and the issuance of cutting instructions to the shop (generally by cross-referencing the assembly marks shown on the shop drawings with the corresponding item covered on the mill purchase order) shall maintain the identity of the mill test report number.

The Contractor may furnish from stock any acceptable material that it can identify by heat number and mill test report.

During fabrication, up to the point of assembling members, each piece of steel other than AASHTO M 183/M 183M steel shall show clearly and legibly its specification identification color code shown in Table 826-F.

Individually marked pieces of steel that are used in the furnished size, or reduced from the furnished size only by end or edge trimming, in a manner that does not disturb the heat number or color, or leave any usable piece, may be used without further color coding provided that the heat number or color code remains legible.

Pieces of steel, other than AASHTO M 183/M 183M steel, that are to be cut to smaller size pieces shall, before cutting, be legibly marked with the AASHTO M 160/M 160M specification identification color code.

Individual pieces of steel, other than AASHTO M 183/M 183M steel, that are furnished in tagged lifts or bundles shall be marked with the AASHTO M 160/M 160 M specification identification color code immediately upon being removed from the bundle or lift.

Pieces of steel, other than AASHTO M 183/M 183M steel, that prior to assembling into members, will be subjected to fabricating operations such as blast cleaning, galvanizing, heating for forming, or painting, which might obliterate paint color marking, shall be marked for grade by low stress, steel die stamping, or by a substantial tag firmly attached.

The identification colors indicated in Table 826-F shall be used to mark materials meeting the individual specifications listed in Table 826-F.

Table 826-F Identification Color Codes

AASHTO	*ASTM*	*Color*
M 244/M 244M	A 514/A 514M	Red
	A 517/A 517M	Red and Blue
M 223/M 223M	A 572/A 572M	Grade 345 Green and Yellow
M 222/M 222M	A 588/A 588M	Blue and Yellow

Other steels, except AASHTO M 183/M 183M steel, that are not covered in Table 826-F and are not included in the AASHTO M 160/M 160M specification shall have an individual color code established and recorded for the Engineer.

Upon request, the Contractor shall furnish an affidavit certifying that throughout the fabrication operation it has maintained the identification of steel in accordance with this Subsection.

826.26 Tests for Structural Members.

(a) *Full Size Tests.* When full size tests of fabricated structural members or eyebars are required by the Contract, the Contract will state the number and nature of the tests, the results to be attained, and the measurements of strength, deformation, or other parameters that are to be performed and recorded. The Contractor shall provide suitable facilities, material, supervision, and labor necessary for performing and recording the tests.

(b) *Non-Destructive Testing.* When non-destructive tests of fabricated structural members are required by the Contract, they shall be done in accordance with Subsection 826.12 (b).

826.27 Erection Marking and Shipping. Each member shall be painted or marked with an erection mark for identification. An erection diagram shall be furnished with erection marks shown thereon.

The Contractor shall furnish the Engineer with three copies of material orders, shipping statements, and erection diagrams as the Engineer may direct. The weights of the individual members shall be shown on the statements. Members weighing more than 3 tons (2.75 metric tons) shall have the weights marked thereon. Structural members shall be loaded on carriers, transported, and unloaded at their destination, without being excessively stressed, deformed, or otherwise damaged.

Bolts of one length and diameter, and loose nuts or washers of each size, shall be packed separately. Pins, small parts, and packages of bolts, washers, and nuts shall be shipped in boxed, crates, kegs, or barrels. The gross weight of any package shall not exceed 300 lb (135 kg). A list and description of the material enclosed shall be plainly marked on the outside of each shipping container.

SHOP PAINTING.

826.28 Urethane Paint System. The Contractor shall select a complete coating system from one manufacturer conforming to the requirements of Subsection 820.02 (a). This selected coating system must be submitted to the Department's Materials and Research Section for approval prior to coating.

The topcoat color of the structural steel shall match color chip No. 24172 (green) of FED-STD-595B, unless otherwise indicated on the Plans. The Contractor shall supply the Engineer with the product data sheets before any painting is done. The product data sheets shall indicate the mixing and thinning directions, the recommended spray nozzles and pressures and all other coating related information.

826.29 General Requirements. Shop painting of metal structures shall consist of shop cleaning, and shop application of the coating system on new structural steel and fasteners with the provision for field application of the topcoat at the option of the Contractor. Included is the cleaning and repair of surfaces damaged in shipping, handling, and erecting the structural steel in accordance with this Specification and as directed by the Engineer.

The coating system shall consist of a coat of inorganic zinc-rich primer, a coat of high-build epoxy, and a urethane topcoat. Terminology used herein is in accordance with the definitions used in Volume 2, Systems and Specifications of the SSPC Steel Structures Painting Manual.

With the exception of abutting joints and base plates, machine finished surfaces shall be painted as soon as practicable after being accepted, and before removal from the shop, with a layer of material meeting the requirements of MIL-C-16173E, automotive grease, or other approved corrosion preventing material.

All structural steel painting will be performed in the shop, except the final coat (topcoat) may be applied in the field after erection. There will be no separate payment for any additional costs of any kind associated with field painting.

826.30 Provisions for Inspection. During fabrication and shop coating, scaffolding shall be furnished and erected, meeting the approval of the Engineer to permit inspection of the steel prior to and after coating.

Rubber rollers, or other protective devices meeting the approval of the Engineer shall be used on scaffold fastenings. Metal rollers or clamps and other types of fastenings which will mar or damage freshly coated surfaces shall not be used.

826.31 Preparation for Shop Coating. All areas shall be blast cleaned to a near-white finish as defined in SSPC-SP 10 for which reference should be made to SSPC Visual Standards. Areas of oil and grease on surfaces to be coated shall be cleaned with clean petroleum solvents prior to blast cleaning. Prior to blast cleaning a beam, the top of the bottom flange shall be scraped to remove any accumulated dirt.

All fins, tears, slivers, and burred or sharp edges that are present on any steel member, or that appear during the blasting operations, shall be removed by grinding and the area re-blasted to give a 1 to 22 mil (25 to 63 mm) surface profile. Scaling hammers may be used to remove heavy scale, but heavier type chipping hammers which would excessively scar the metal shall not be used.

The abrasive used for blast cleaning shall be in accordance with Subsection 605.45, and shall have a gradation such that the abrasive will produce a uniform profile of 1 to 22 mil (25 to 63 mm), as measured with Testex Replica Tape.

All abrasive and paint residue shall be removed from steel surfaces with a good commercial grade vacuum cleaner equipped with a brush-type cleaning tool, or by double blowing. If the double blowing method is used, the exposed top surfaces of all structural steel, including flanges, longitudinal stiffeners, splice plates, hangers, etc., shall be vacuumed after the double blowing operations are completed. The air line used for blowing the steel clean shall have an in-line water trap and the air shall be free of oil and water as it leaves the air line. The steel shall then be kept dust free, and primed within eight hours after blast cleaning.

Care shall be taken to protect freshly coated surfaces from subsequent blast cleaning operations. Blast damaged primed surfaces shall be thoroughly wire brushed or, if visible rust occurs, re-blasted to a near-white condition. The wire brushed or blast cleaned surfaces shall be vacuumed and re-primed.

All areas where field welding is required, shall be masked prior to applying the primer. Areas where shear stud connectors will be welded to the top flange shall be masked after the primer coat has been applied, but before the epoxy coat is applied.

826.32 Painting Conference. Before fabrication of the structural steel begins the appropriate parties involved shall attend a "Post-Award Painting Conference".

Present at the conference shall be the following:

a. Contractor.
b. Steel fabricator and its coating specialist.
c. Paint and coating material supplier including local technical and sales representative plus any other experienced personnel.
d. Engineer.

The purpose of the conference is to discuss the specifications in detail and ensure that the painting work conforms to the manufacturer's product data sheets and application instructions as well as the requirements of this Section.

The discussions shall include:

a. Equipment use and servicing.
b. Material storage.
c. Application techniques (including thickness tolerances).
d. Definition of the degree of cleaning, i.e., SSPC Pictorial Standards.
e. Surface preparation of shop-primed surfaces by shotblasting or sandblasting, describing abrasive to be used, necessary air pressure at the blast nozzle, etc.
f. Inspection requirements including surface preparation, wet and dry film thickness checking, techniques, and equipment to be used.
g. Inspection Reports.
h. Safety precautions stated in the manufacturer's printed instructions.Availability of the work for inspection by the Engineer.

826.33 Painting.

a. *Mixing the Paint.* The paint shall be mixed with a high shear mixer such as Jiffy Mixer, in accordance with the manufacturer's directions, to a smooth, lump-free consistency. Paddle mixers or paint shakers are not allowed. Mixing shall be done thoroughly, in the original containers, and shall be continued until all the metallic powder or pigment are in suspension.

   Care shall be taken to ensure that all of the paint solids that may have settled to the bottom of the container are thoroughly dispersed. The paint shall then be strained through a screen having openings no larger than those specified for a No. 50 (300 Fm) sieve in AASHTO M 92. After straining, the mixed paint shall be kept under continuous agitation up to and during the time of application.

b. *Thinning the Paint.* In general the paints are supplied for normal use without thinning. If it is necessary to thin the paint for proper application in cool weather, or to obtain better coverage of the urethane topcoat, the thinning shall be done in accordance with the manufacturer's recommendations and shall be subject to the Department's approval.

c. *Conditions for Painting.* Paint shall be applied only when the following conditions have been met:

1. *Temperature.* The temperature of the air and the steel shall be above 50 ºF (10 ºC) for paint other than the topcoat. This 50 ºF (10 ºC) minimum temperature shall be maintained throughout the minimum time between coats as listed in the Qualified Products List. For the urethane topcoat, the temperature of the air and steel shall be above 40 ºF (4 ºC). Coatings shall not be applied if the temperature is high enough to cause blistering. The surface temperature of the steel shall be at least 5 ºF (3 ºC) higher than the dew point.
2. *Humidity.* The paint shall not be applied when the relative humidity is greater than 90%, nor when a combination of temperature and humidity conditions are such that moisture condenses on the surface being painted.

d. *Applying the Paint.* After the surface to be coated has been cleaned and approved by the Engineer, the primer shall be applied so as to produce a uniform even coating bonded with the metal. Succeeding coats shall be applied when approved by the Engineer. The minimum curing time between coats shall be according to the manufacturer's specifications. Depending on site conditions, additional time may be required for proper curing before applying succeeding coats. Cure time for proper application of succeeding coats shall not be less than the minimum nor exceed the maximum as recommended by the paint manufacturer. The Contractor shall provide the Engineer written documentation of manufacturer recommended cure times and any pre-treatments of existing coats prior to application of succeeding coats. It is the applicator's responsibility to determine the condition of each coat prior to application of succeeding coats. Any oxidation products, chalking, salts, residue or other surface condition that form on existing paint surfaces and interfere with proper adhesion shall be completely removed in accordance with manufacturer recommendations or as directed by the Engineer. Removal shall be accomplished through water blasting, solvent wiping, brush-off blasting or other means as necessary to properly prepare the surface for coating.

The coatings shall be applied with the spray nozzles and pressures recommended by the producer of the coating system, so as to attain the film thicknesses specified. All surfaces, including faying (contact) surfaces, and flange tops, shall be shop primed by spray in accordance with SSPC-PA 1. The intermediate coat shall also be applied in the shop in accordance with SSPC-PA 1. The topcoat shall be shop applied or field applied after steel erection at the Contractor's option. Faying surfaces and surfaces to be in contact with Portland cement concrete shall not receive the intermediate and topcoats.

Flange tops shall receive a fog coat of between 2 and 3/4 mils (12 and 19 mm) of inorganic zinc primer. The dry film thickness of the primer coat on the bolted friction splices on the main members shall not be less than 1 mil (25 mm) or greater than 22 mils (63 mm). The faying surfaces of bolted field splices, bolted shop splices, or any other bolted faying surfaces, shall be masked during subsequent coating operations. In the areas of field bolted connections (including the outside surface of splice plates), the outside surfaces shall be primed a minimum of 4 mils (100 mm). On all other areas, the minimum dry film thickness for the primer coat shall also be 4 mils (100 mm), for the epoxy coat it shall be 32 mils (88 mm), and for the urethane protective coat it shall be sufficient to provide a uniform color and appearance but in no case shall be less than 1 mil (25 mm).

The dry film thickness will be determined by the use of a magnetic dry film thickness gage. The gage shall be calibrated on the blasted steel with plastic shims approximately the same thickness as the minimum dry film thickness. A Tooke film thickness gage may be used to verify the coating thickness when requested by the Engineer. If the Tooke gage shows the primer coat to be less than the specified minimum thickness, the total coating system will be rejected even if the total dry film thickness exceeds the total of the minimum for each coat of the three-coat system.

All bolted shop connections and shop bolted cross frames or diaphragms shall be removed and disassembled prior to the blasting and coating of the girders or beams. The parts shall be blasted separately, primed, then reassembled and the bolts fully tightened in accordance with the applicable specifications.

All galvanized components in bolted shop connections, including mechanically galvanized nuts, bolts, and washers, shall be solvent cleaned, given a tie coat, if recommended by the paint manufacturer, and then coated with both the epoxy coat and the urethane protective coat.

If the application of the coating at the required thickness in one coat produces runs, bubbles, or sags, the coating shall be removed and reapplied in multiple passes of the spray gun, the passes separated by several minutes. Where excessive coating thickness produces "mud-cracking", such coating shall be scraped back to soundly bonded coating and the area recoated to the required thickness.

In areas of deficient primer thickness, the areas shall be thoroughly cleaned with power washing equipment, as necessary, to remove all dirt; the areas shall then be wire brushed, vacuumed, and recoated.

All coating shall be done in a neat and workmanlike manner as described in SSPC-PA 1, producing a uniform, even coating which is bonded to the underlying surface.

Erection marks, for the field identification of members, and weight marks shall be transferred or preserved.

All metal coated with impure, unsatisfactory, or unauthorized coating material, or coated in an unworkmanlike or objectionable manner, shall be thoroughly cleaned and recoated or otherwise corrected as directed by the Engineer.

All dry spray shall be removed, by sanding if necessary, prior to the application of the succeeding coat.

Material shall not be loaded for shipment until the shop coating has been adequately cured and inspected. The components will be stamped "Recommended for Use" only after the loading has been completed and approved.

826.34 Stenciling Requirement. At the completion of the painting work, the completion date (month and year) and the bridge number, shall be stenciled on the structure in 3'' (75 mm) numbers. The paint used for this marking shall be the same as the topcoat except the color shall be black. The numbers shall be stenciled on the outside of each fascia beam at the approaching traffic end of the structure, on a location designated by the Engineer.

826.35 Handling Steel. Extreme care shall be exercised in handling the steel in the shop, during shipping, during erection, and during subsequent construction of the bridge. The steel shall be insulated from the binding chains by softeners approved by the Engineer. Hooks and slings used to hoist steel shall be padded. Diaphragms and similar pieces shall be spaced in such a way that no rubbing will occur during shipment that may damage the coatings. The steel shall be stored on pallets at the job site, or by other means approved by the Engineer, so that it does not rest on the dirt or so that components do not fall or rest on each other. All shipping and job site storage details shall be presented to the Engineer at the "Post-Award Painting Conference" and they must be approved prior to shipping the steel.

826.36 Field Repair and Field Coating. The Contractor shall furnish and erect scaffolding meeting the approval of the Engineer and shall provide a time mutually agreed upon for inspecting the structural steel prior to and after coating.

Rubber rollers, or other protective devices meeting the approval of the Engineer, shall be used on scaffold fastenings. Metal rollers or clamps and other types of fastenings which will mar or damage freshly coated surfaces shall not be used.

All field repairs shall be made in strict accordance with the coating supplier's recommendations and shall be approved by the Engineer. All coatings applied to repair areas shall be applied using recommended spray equipment only. The coating supplier's recommendations are to be supplied to the field personnel by the fabricator of the steel. Such field repairs shall include the application of the following coating system; e.g., on rusted areas: the zinc-rich primer, the epoxy intermediate coat, and the urethane protective coat; on non-rusted areas (where the primer is at least equal to the minimum required dry film thickness): the epoxy intermediate coat and the urethane protective coat; and on galvanized components: the tie coat, the epoxy intermediate coat, and the urethane protective coat.

Surfaces which will be inaccessible for coating after erection shall be repaired and/or recoated prior to erection.

When the erection work has been completed, including all connections and the straightening of any bent metal, the steel shall be prepared for repairs. All adhering scale, dirt, grease, form oil, or other foreign matter shall be removed by appropriate means and any rusted or uncoated areas blast cleaned to a near-white finish in accordance with SSPC-SP 10. All abrasive and paint residue shall be removed from steel surfaces by vacuuming or by double blowing, except that if the double blowing method is used, the top surfaces of all structural steel, including top and bottom flange, splice plates, hangers, etc., shall be vacuumed after the double blowing operations are completed. The coating surrounding the blasted area shall be thoroughly wire brushed, vacuumed, and the area recoated with the same coating system used in the shop. When spraying a blasted area or an area of insufficient primer thickness, the surrounding area will be coated with primer. Prior to the application of the intermediate coat, the area around the area where the primer has been repaired shall be adequately rubbed to remove the primer from the surrounding epoxy or urethane. The requirements specified herein for provisions for inspection, mixing the coating, thinning the coating, temperature, and humidity requirements for coating, and applying the coatings, shall govern application of the topcoat and application of the coating to the repaired areas. The requirements for the dry film thickness of the topcoat and the repair coats are the same as for the shop coats. Proper curing conditions will be required prior to application of the topcoat and between applications of the repair coats as previously specified herein.

Mechanically galvanized nuts, bolts, and washers shall be coated in accordance with the recommendations of the manufacturer of the coating system. This procedure shall include the removal of any lubricant or residuals on the surface and the application of a tie coat prior to application of the field coats. This tie coat shall be brushed or sprayed as specified by the manufacturer. The epoxy and urethane shall then be applied to the bolts and the surrounding connection surfaces.

Any temporary attachments or supports for scaffolding or forms shall not damage the coating system. (In particular, on the fascias where bracing is used, sufficient size support pads must be used.) Any damage that occurs from such devices shall be repaired by the same procedure as for a field repair.

If the stenciling which was applied at the completion of the shop coating is marred or damaged, the marking shall be repaired as directed by the Engineer. The paint used for this marking repair shall be the same as the urethane protective coat used in the field repairs except the color shall be black.

826.37 Protection of the Work. Pedestrian, vehicular, and other traffic upon or underneath the structure shall be protected in accordance with Section 107. All portions of the structures (superstructure, substructure, slope protection and highway appurtenances) shall be protected against splatter, overspray splashes, and smirches of coating or coating material by means of protective covering suitable for the purpose. The Contractor shall be responsible for any damage caused by his operations to vehicles, persons or property.

Whenever the intended purposes of the protective devices are not being accomplished, work shall be suspended until corrections are made.

SECTION 827 GEOTEXTILE

827.01 Description. This material consists of geotextile for use in constructing silt fence; reinforced silt fence; inlet sediment control; sediment trap outlet, riser pipe; riprap ditch; perimeter dike/swale; earth dike; temporary slope drain; stilling well; sump pit; stabilized construction entrance; portable sediment tank; geotextile lined channel diversion; dewatering basin; sediment basin outlet structure, corrugated metal; and other soil sediment and erosion control applications.

827.02 Silt Fence. The geotextile shall be a minimum of 36'' (900 mm) wide and shall be a woven fabric consisting of long chain polymeric filaments, or yarns such as polypropylene, polyethylene, polyester, polyamide, or polyvinylidene-chloride, formed into a stable network such that the filaments or yarns retain their relative position to each other. The geotextile shall be inert to commonly encountered chemicals and shall meet the requirements listed in the following table:

Table 827-A		
Property	*Test Method*	*Value*
		(Average Minimum Roll Value)
Grab Tensile Strength	ASTM D 4632	489 N
Grab Tensile Elongation	ASTM D 4632	20%
Mullen Burst Strength	ASTM D 3786	1.4 kPa
Trapezoid Tear Strength	ASTM D 4533	222 N
Slurry Flow Rate	VA DOT, VTM 51	200 mL/sec/m^2
Weight	ASTM D 3776	0.02 lb/ft5 (0.1 kg/m^2)
Ultraviolet Stability	ASTM D 4355 after 500 hours	70%
(Strength Retained)	of Xenon-Arc Type Apparatus	

827.03 Reinforced Silt Fence. The geotextile shall conform to the requirements of Subsection 827.02.

827.04 Inlet Sediment Control. The geotextile shall be Mirafi 140N, Linq GTF 130D, Amoco 4545, or an equal approved for use by the Department's Materials and Research Section. Table 827-B illustrates the flow rates of the various fabrics. Any material submitted as an equal must have a flow rate equal to or exceeding the minimum flow rate of those listed in the following table:

Table 827-B			
Geotextile Manufacturer	*Geotextile Style*	*Flow Rate*	
		gal/min/ft5	*(L/sec/m5)*
Mirafi	140 N	120	(82)
	4030 A	145	(99)
Amoco	4545	150	(102)
	4535	155	(105)
Linq	103 EX	140	(95)
	125 EX	150	(102)

827.05 Riser Pipe Assembly for Sediment Trap. The geotextile shall conform to the requirements of Subsection 827.04.

827.06 Riprap Ditch. The geotextile shall be Mirafi 700X or Erosion 1 manufactured by Synthetic Industries, Linq GTF 400E or Poly-Filter X manufactured by Carthage Mills, TerraTex Ep manufactured by WEBTEC, Inc., or an equal approved by the Department's Materials and Research Section.

827.07 Perimeter Dike/Swale. The geotextile shall conform to the requirements of Subsection 827.06.

827.08 Earth Dike. The geotextile shall conform to the requirements of Subsection 827.06.

827.09 Temporary Slope Drain. The geotextile shall conform to the requirements of Subsection 827.06.

827.10 Stilling Well. The geotextile shall conform to the requirements of Subsection 827.06.

827.11 Sump Pit. The geotextile shall conform to the requirements of Subsection 827.04.

827.12 Stabilized Construction Entrance. The geotextile shall be woven or nonwoven and shall consist only of continuous chain polymer filaments or yarns of polyester. The geotextile shall be inert to commonly encountered chemicals and hydrocarbons, be mildew and rot resistant, and shall conform to the properties of the following table:

Table 827-C

Fabric Properties	*Traffic* *# 3 Axles*	*Traffic* *> 3 Axles*	*Test Method*
Grab Tensile Strength	890 N	980 N	ASTM D 4632
Elongation at Failure	50%	220%	ASTM D 4632
Mullen Burst Strength	845 N	1.9 kN	ASTM D 3786
Puncture Strength	178 N	556 N	ASTM D 751, Modified
Equivalent Opening Size	180 to 425 µm	180 to 425 µm	Standard Sieve CW-02215

827.13 Portable Sediment Tank. The geotextile shall conform to the requirements of Subsection 827.04.

827.14 Geotextile Lined Channel Diversion. The geotextile shall conform to the requirements of Subsection 827.06.

827.15 Dewatering Basin. The geotextile shall conform to the requirements of Subsection 827.06.

827.16 Sediment Basin Outlet Structure, Corrugated Metal. The geotextile shall conform to the requirements of Subsection 827.04.

SECTION 828 GUARDRAIL

828.01 Description. This material consists of guardrail, structural steel posts, and related hardware.

828.02 Material Requirements.

1. *Steel Posts, Steel Offset Blocks, and Steel Shapes.* Steel posts, offset blocks, shapes, and all structural steel parts shall conform to the requirements of AASHTO M 183/M 183M, or shall be fabricated sections conforming to the requirements of ASTM A 769/A 769M. All shapes, except beams, shall be hot-dipped galvanized in accordance with AASHTO M 111.

   The Contractor may elect to use either hot-dipped galvanized rolled H sections or fabricated sections, that conform to the requirements of ASTM A 769/A 769M, Grade 36 (Grade 250).
2. *Beams.* All beams shall conform to the requirements of AASHTO M 180, Class A, Type I or Type I
3. *Hardware.* Bolts, nuts, and washers shall be the manufacturer's standard shoulder bolts for the purpose intended and shall conform to the requirements of AASHTO M 180. All hardware shall have a zinc coating conforming to the requirements of AASHTO M 232.
4. *Rods and Turnbuckles.* Rods and turnbuckles shall have a minimum tensile strength of 60,000 lb (270 kN). Rods, nuts, turnbuckles, and washers shall be hot-dipped galvanized according to the requirements of AASHTO M 111.
5. *Swaged Cable Assembly for Guardrail End Tre.* Threads for the stud shall be manufactured according to ANSI B1.13M, M24 x 3 - 6g. The cable shall be swaged into the fitting. The stud shall conform to ASTM F 568, Class C or AASHTO M 298 (ASTM B 695), Class 50. The 3/8'' (10 mm) slot for the locking pin shall be milled into the stud end prior to the application of the zinc coating.

   The swaged fitting shall be machined from hot-rolled carbon steel conforming to ASTM A 576, Grade 1035, and zinc-coated according to AASHTO M 111 (ASTM A 123) before swaging. The material shall be annealed suitably for cold swaging. A lock pin hole to accommodate a 3'' (6 mm) plated spring-steel pin shall be drilled through the head of the swaged fitting to retain the stud in the proper position.

   The wire rope shall be 3/4'' (19 mm) diameter, 6 by 19 wire stem+core or independent wire rope core (IWRC), zinc-coated, right regular lay wire rope conforming to AASHTO M 30. The wire rope steel shall be improved steel with a minimum breaking strength of 42,000 lb (190 kN). The swaged fitting, stud, and nuts shall develop the breaking strength of the wire rope.

6. *Reflectorized Washers.* Reflectorized washers for guardrail posts shall consist of double-faced reflectorized washer units. Washers shall be fabricated from aluminum plates conforming to the requirements of ASTM B 209M, Alloy 5052-H32. Retroreflectorized sheeting conforming to the requirements of AASHTO M 268 shall be applied to the washer.
7. *Timber Post, Blocks and Offset Blocks*. Timber post, blocks, and offset blocks shall conform to the dimensiions shown on the Standard Construction Details. Timber used for post, blocks and offset blocks shall conform to the requirements of Section 601 and the preservative treatment requirements of Section 814(b). Offset blocks made of composite material tested and approved under National Cooperative Highway Research Program (NCHRP) Report 350 Criteria will also be acceptable.

   Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.

SECTION 829 ANTI-STRIPPING ADDITIVES

The antistripping additive shall be oil soluble and, when added to asphalt cement, shall promote strong adhesion characteristics with aggregates, shall be compatible with the asphalt cement in which it is to be added, shall not change the basic characteristics of the asphalt cement, and shall be heat-stable when added at the manufacturer's recommended dosage for a minimum of 96 hours at the bituminous materials normal storage temperature.

The antistripping additive for bituminous concrete shall be evaluated according to the requirements of AASHTO R 15. Testing shall conform to the requirements of AASHTO T 283. The TSR shall be a minimum of 80.